33d CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 91.

U.S.

REPORTS

OF

EXPLORATIONS AND SURVEYS,

TO

ASCERTAIN THE MOST PRACTICABLE AND ECONOMICAL ROUTE FOR A RAILROAD

FROM THE

MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

MADE UNDER THE DIRECTION OF THE SECRETARY OF WAR, IN

1853-4,

ACCORDING TO ACTS OF CONGRESS OF MARCH 3, 1853, MAY 31, 1854, AND AUGUST 5, 1854.

Botany by Torrey and Gray

VOLUME II.

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WASHINGTON:
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1855.

CONTENTS OF VOLUME II.

REPORT, BY LIEUTENANT E. G. BECKWITH, THIRD ARTILLERY, UPON THE ROUTE NEAR THE THIRTY-EIGHTH AND THIRTY-NINTH PARALLELS, EXPLORED BY CAPTAIN J. W. GUNNISON, CORPS TOPOGRAPHICAL ENGINEERS.

REPORT OF LIEUTENANT E. G. BECKWITH, THIRD ARTILLERY, UPON THE ROUTE NEAR THE FORTY-FIRST PARALLEL.

*REPORT OF A RECONNAISSANCE FROM PUGET SOUND, VIA SOUTH PASS, TO THE MISSISSIPPI RIVER, BY F. W. LANDER, CIVIL ENGINEER.

REPORT OF BREVET CAPTAIN JOHN POPE, CORPS TOPOGRAPHICAL ENGINEERS, UPON THE PORTION OF THE ROUTE NEAR THE THIRTY-SECOND PARALLEL, LYING BETWEEN THE RED RIVER AND THE RIO GRANDE.

REPORT OF LIEUTENANT JOHN G. PARKE, CORPS TOPOGRAPHICAL ENGINEERS, UPON THE PORTION OF THE ROUTE NEAR THE THIRTY-SECOND PARALLEL, LYING BETWEEN THE RIO GRANDE AND PIMAS VILLAGE, ON THE GILA.

EXTRACT FROM REPORT OF A MILITARY RECONNAISSANCE MADE BY LIEUTENANT COLONEL W. H. EMORY, U. S. ARMY, OF THE PORTION OF THE ROUTE NEAR THE THIRTY-SECOND PARALLEL, LYING BETWEEN THE MOUTHS OF THE SAN PEDRO AND GILA RIVERS.

*This report was procured from Mr. Lander in compliance with a resolution of the House of Representatives of August 3, 1854. By a resolution of February 14, 1855, it was ordered to be printed, in connexion with the reports of the Pacific railroad explorations and surveys made under direction of the Secretary of War.

IN THE HOUSE OF REPRESENTATIVES—FEBRUARY 14, 1855.

Resolved, That there be printed, for the use of the House, ten thousand copies of the reports of surveys for a railroad to the Pacific, made under the direction of the Secretary of War, embracing the report of F. W. Lander, civil engineer, of a survey of a railroad route from Puget's Sound, by Fort Hall and the Great Salt lake, to the Mississippi river; and the report of J. C. Frémont, of a route for a railroad from the head-waters of the Arkansas river into the State of California; together with the maps and plates accompanying each of said reports necessary to illustrate them.

Attest:

J. W. FORNEY,

Clerk of the House of Representatives of the United States.

THIRTY-SECOND CONGRESS, SECOND SESSION—CHAPTER 98.

SECT. 10. *And be it further enacted*, That the Secretary of War be, and he is hereby authorized, under the direction of the President of the United States, to employ such portion of the Corps of Topographical Engineers, and such other persons as he may deem necessary, to make such explorations and surveys as he may deem advisable, to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean, and that the sum of one hundred and fifty thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, appropriated out of any money in the treasury not otherwise appropriated, to defray the expense of such explorations and surveys.

Approved March 3, 1853.

THIRTY-THIRD CONGRESS, FIRST SESSION—CHAPTER 60.

Appropriation: For deficiencies for the railroad surveys between the Mississippi river and the Pacific ocean, forty thousand dollars.

Approved May 31, 1854.

THIRTY-THIRD CONGRESS, FIRST SESSION—CHAPTER 267.

Appropriation: For continuing the explorations and surveys to ascertain the best route for a railway to the Pacific, and for completing the reports of surveys already made, the sum of one hundred and fifty thousand dollars.

Approved August 5, 1854.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

REPORT

OF

EXPLORATIONS FOR A ROUTE FOR THE PACIFIC RAILROAD,

BY

CAPT. J. W. GUNNISON, TOPOGRAPHICAL ENGINEERS,

NEAR

THE 38TH AND 39TH PARALLELS OF NORTH LATITUDE,

FROM

THE MOUTH OF THE KANSAS RIVER, MO., TO THE SEVIER LAKE, IN THE GREAT BASIN.

REPORT

BY LIEUT. E. G. BECKWITH,

THIRD ARTILLERY.

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INTRODUCTORY LETTER.

WASHINGTON, D. C., *November* 25, 1854.

SIR: In submitting to the department the accompanying report of the explorations for a Pacific railroad, conducted, up to the time of his death, (at the hands of the Indians,) by the late Captain J. W. Gunnison, Topographical Engineers, it is proper that I shall state that I have preferred the journal form in which to embody the labors of the party and the minute and general descriptions of the country, required by the specific object of the survey, as affording greater facilities for introducing the observations and conclusions of Captain Gunnison, in his own language, than could have been secured in any other form. I have intentionally adhered to details and repetitions, however monotonous, by which alone a faithful description of this great interior country can be presented; for, monotonous as it is in itself, and far removed from general fertility, no general description not made up of facts constantly repeated can convey a true picture of the country explored—an object deemed of the first importance in this report, in which I have endeavored to exhaust the material obtained for it, for which too much credit cannot be given to Captain Gunnison.

The report was written, in great haste, at Great Salt Lake, immediately after reaching that city, and forwarded to you on the 1st of February, 1854, but has been revised and materially improved since my return to this city. The computation of altitudes has been conducted since my arrival in Washington under the superintendence of Mr. Lorin Blodget, and the barometrical observations discussed by him with great care and superior intelligence, which will be apparent by a reference to his notes and the tables in this report.

I am, sir, most respectfully, your obedient servant,

E. G. BECKWITH,
First Lieutenant 3d Artillery.

Hon. JEFFERSON DAVIS,
Secretary of War.

CONTENTS.

CHAPTER I.

From Fort Leavenworth, via Westport, Fort Riley, and Smoky Hill Fork, to Pawnee Fork; also, via Santa Fé road to Council Grove and Walnut Creek—June 15th to July 13, 1853.

Page.

Allusion to the death of Captain Gunnison and his assistants.—Extract from instructions from the War Department to Captain Gunnison.—Arrival at St. Louis, Kansas, and Fort Leavenworth.—Country from Fort Leavenworth to Westport.—Camp at Shawnee Mission, near Westport: its altitude above the Gulf of Mexico.—Arrival of the escort under Captain Morris.—Teamsters and mules.—First march.—Gentlemen composing the party.—Instruments provided.—The train: why used.—Cedar creek: its timber.—Bull creek.—McClannahan and party, with stock for California.—Emigrants.—Division of party.—Route via Kansas river and Smoky Hill Fork.—Wahkarrussi bottom.—Timber.—Inviting appearance of the Kansas bottom: its fertility and railroad practicability.—Indian houses and grain fields.—Delaware guides.—Uniontown.—Rocky hills.—Storm.—Country approaching Fort Riley.—Crossing the Kansas.—Fort Riley.—Crossing the Republican Fork or Pawnee river.—Valley of the Smoky Hill Fork: its fertility and timber.—Sycamore creek.—Wagon road route from Fort Riley west.—Sand-hills.—Crossing Nepeholla or Solomon's Fork.—Short grass begins to appear.—Practicability of a wagon road to the Saline Fork.—Stream swollen: its passage and character.—First appearance of buffalo-grass.—Meadows of the Saline and Kansas rivers.—Smoky Hill.—Buffalo sign.—Lone Oak ford of the Kansas.—Railroad line thence to the Huerfano.—Sandstone ridges or bluffs.—Character of the soil.—Chalybeate spring.—First buffalo.—Passing from the waters of the Smoky Hill to those of the Arkansas river.—Sand-banks on the Little Arkansas.—Large fields of helianthus.—Indicated line for a wagon road west from Fort Riley.—Walnut creek.—Military parties and encampments.—Guides discharged.—Character of the country for roads of any kind.—Bridges.—Change in climate and character of the country.—Journal of the party following the Santa Fé road from Bull creek.—Black Jack creek.—Timber.—Bituminous coal.—Willow spring.—Stampede of emigrant horses.—Rock creeks.—One Hundred and Ten Mile creek.—Indian houses and fields.—Dwissler's, Dragoon, and Prairie Chicken creeks.—Elm, Bluff, and Big Rock creeks.—Council Grove.—Timber and fields of corn.—Civil and military parties en route for New Mexico.—Incident in Governor Merriwether's life.—Diamond spring.—Lost spring.—Scarcity of timber and monotonous character of the country.—Snipe.—Cottonwood creek.—Annoyance from flies and mosquitoes.—Turkey creek.—Miserable water.—Little Arkansas.—View of the Arkansas river bottom.—Owl and Cow creeks.—Change in the character of the soil and vegetation of the country.—Dog towns.—Sand-hills.—Arkansas river.—Kansas, Osage, and Sac Indians.—Walnut creek.—Suffering from mosquitoes.—Site for a military post.—Timber on Walnut creek.—Pawnee Rock.—Ferruginous sandstone.—Ash creek.—Grass and soil.—Pawnee Fork.—Timber.—Altitude of camp on Pawnee Fork above, and distance from, that near Westport.—Osage and Kansas Indians..... 9

CHAPTER II.

From Pawnee Fork to the crossing of the Arkansas river at the mouth of the Apishpa—July 14 to August 2, 1853.

Forks of the Santa Fé road.—Coon creek: bad water.—Indian hunting grounds.—Dryness of the country.—Bois de vache.—Wolf in pursuit of a rabbit.—Return to the Arkansas river.—Comanche Indians.—Fort Atkinson.—Dryness of the Arkansas river at times.—Kioway camp.—Indian war party against the Pawnees.—Shaved-Head, a Comanche chief: his leave-taking.—Captives among Indians.—Ascent from Pawnee Fork.—Grass of the country.—Bluffs and rolling prairie.—Islands in the river.—Cimmaron route ford.—Line of proposed road from Fort Riley to this ford.—Sandy road.—Plains of the river bottom.—Scarcity of fuel.—Dull monotony of the Arkansas.—Winds.—Altitude above Fort Atkinson and distance from it: altitude above the Gulf of Mexico.—Unsuccessful sportsmen.—Prairie dogs in great numbers.—Incrustations of salt.—Iron ore.—Big Timber.—Bent's trading station.—Sandstone bluffs.—Scarcity of grass—Purgatory creek.—Bent's Fort.—Game.—Fords.—Advantageous position for a military post.—Timpas creek.—Railroad route indicated.—Smoky atmosphere.—View of the Spanish peaks.—Artemisia.—Game.—Crossing the Arkansas at the mouth of the Apishpa.—The river easily bridged.—Hills and bluffs.—Grades for thirty-four miles.—View of the mountains and peaks..... 24

CHAPTER III.

From the mouth of the Apishpa, via the Sangre de Cristo, to Roubideau's Pass—August 2 to 25, 1853.

Page.

Valley of the Apishpa.—Rocks and soil of the hills and valley.—Small cañon.—Examination of the cañon.—Indian writings.—Cacti.—Small pines.—Route of the wagon train.—Rocks and grass.—Game.—Appearance of the mountains.—Fossils.—Flowers.—Wild horses.—Timber on the Arkansas in sight.—Rains, dews, winds.—Course of the Apishpa, and broken character of the country.—Discovered that we were not on the Huerfano.—Road to Raton Pass.—Cuchara river.—Fine view.—Trip to the Greenhorn settlement.—Clay and shale banks of the Cuchara.—Dog towns.—Wild horses.—Huerfano river and butte.—Huerfano cañon.—Apache creek.—Trail from Taos.—Trader's camp.—Granaros.—Greenhorn settlement: its population and productions.—Massalino, the guide.—Sleeping apartments in Greenhorn.—Huerfano butte.—Direct line from the Arkansas to the upper Huerfano, leaving the former above the mouth of the Apishpa: its railroad character.—Size of the Huerfano river.—Soil.—Building-stone.—Ascent of the Huerfano.—Taos trail, via El Sangre de Cristo Pass.—Approach to the Sangre de Cristo Pass.—Sand and limestone.—Railroad route.—Timber.—Flowers.—Game.—Difficulties in the approach.—The passage of the Sangre de Cristo Pass.—Scenery.—Game.—Distances, altitudes, grades.—Railroad line through the pass and its western descent to Fort Massachusetts.—Examination of the mountains to the south of the Spanish peaks.—Hunters from Taos.—Snow in and about the Sangre de Cristo Pass.—Trip to Taos.—San Luis valley: its streams and settlements.—Indian signals and robbery.—Red river of the Rio Grande del Norte.—Valley of Taos: its settlements and cultivation.—Return to Fort Massachusetts.—Antoine Leroux, guide.—Men discharged.—Mr. Taplin.—White Mountain spring.—Sage in San Luis valley.—Roubideau's Pass: its rocks, character, grades, elevation.—San Luis valley, and mountain chains enclosing it..... 31

CHAPTER IV.

From Roubideau's Pass, via the Coochetopa Pass and Grand River valley, to the Nah-un-kah-rea or Blue river—August 25 to September 20, 1853.

Gigantic sand-hills.—Williams' Pass.—Stampede.—Sand and sage.—Chatillon, Trois Teton, and Leroux creeks.—Game.—Scene of Colonel Frémont's disaster of 1848-'49.—Vegetation and soil.—Homans' creek.—Currants.—Sahwatch spring and butte.—Coochetopa Pass gate.—Sinking of Sahwatch creek.—Sahwatch valley.—Light dusty soil.—General character of San Luis valley.—Favorable character for a railroad of the lower part of the Sahwatch valley.—Deer, grouse, and trout.—Captain Gunnison's examination of Homans' park: its fertility.—Gunnison's Pass: its position and railroad practicability.—Puncha creek and country east of the pass.—Indicated lines for roads.—Mountain sheep.—Approach to the Coochetopa Pass.—Carnero Pass.—Leaving Sahwatch creek.—Mountain forms, timber, rocks.—Passage and character of the summit of the Coochetopa Pass: altitudes and grades in approaching it, &c.—Method of levelling.—Grades and tunnel.—Existence of a pass north of the Coochetopa Pass.—Valley of Pass creek.—Valley leading to Carnero Pass.—Grades.—Indicated railroad line from the Coochetopa Pass.—Artemisia.—Coochetopa creek.—Pass Creek cañones.—Character of mountain storms.—Grand river: its character, valley, and adjacent mountains.—Confusion of names.—Character of and passage around the first cañon of Grand river.—Tables or mesas.—Brief general description of Grand River valley and cañones.—Fall of the river.—Ice.—Indian smokes and method of hunting.—Captain Gunnison's description of Grand River valley repeated.—Railroad difficulties.—Scarcity of timber.—The guide's dilemma.—Difficulties, character, and passage of Lake Fork.—Delusive basin appearance, exhibiting the broken character of the country.—Effects of mountain air.—View of the Sierra de la Plata.—Utah Indians on Cebolla creek.—Indian presents.—Mountain reconnoissance.—Fine view of distant mountain peaks and adjacent valleys and streams.—Position of the Spanish trail.—Ascent and passage of the mountain.—Ascending and descending grades.—Valley of the Uncompahgra: its cacti, sage, soil, &c.—Utah Indians.—Women of great age.—Domestic scene.—Descent of the Uncompahgra valley.—Utah Indian parties: great numbers in camp.—Indian "talk" and presents.—Roubideau's old fort.—Crossing Grand river.—Difficulties to be encountered in constructing a railroad along the cañon portion of Grand river.—Character of the country below Roubideau's old fort.—Una-weep cañon and creek.—Kah-nah creek.—Nah-un-kah-rea or Blue river.—Steep eastern bank.—River crossing.—River entrance into this valley; its size and character..... 43

CHAPTER V.

From Blue river crossing to Green, White, and San Rafael rivers and the eastern foot of the Wahsatch Pass—September 20 to October 13, 1853.

Purchase of Indian horses.—Indian veracity.—Soil.—Salt creek.—Indian trails to the Uintas.—Coal bed.—Cañones of Grand river.—Rocks.—Coal.—Daily change of temperature.—Aqueous deposits and barrenness of the valleys.—Climate.—Scarcity of cultivable lands.—Leroux returns to New Mexico.—Details of the country between Grand and Green rivers.—Best position for railroad indicated: grades, &c.—Fanciful forms of mountains.—Reach the noted Spanish trail.—Disheartening view.—Ash-heap character of the soil.—Scarcity of water.—Difficulty in the construction of a railroad from Grand to Green river.—Crossing Green river.—Utah Indians.—Character of Roan mountains

Page.

on Green river.—Spanish trail followed to Akanaquint spring.—Grades.—From Akanaquint spring to White river: rocks, soil, water, and grades.—Ascent of the valley of White river to Clever creek.—Return to White river.—San Rafael river.—Return to the Spanish trail.—Course of this trail, and character of the country traversed by it from Akanaquint spring.—Indicated line via the San Rafael.—Improved soil.—Indians subsist on buffalo-berries.—The country between Green river and the Wahsatch mountains: valleys, hills, and rocks. Oak springs.—Indian guide.—Weak condition of our animals.—Grades 53

CHAPTER VI.

From the eastern base of the Wahsatch mountains, via the Wahsatch Pass and Sevier river, to near the Sevier lake, the most western point of exploration, and back to Cedar Springs, after the death of Captain Gunnison—October 13 *to* 28, 1853.

Akanaquint creek.—Rude figures drawn on rocks.—The Wahsatch Pass.—Character of the hills to the east and west of the pass.—Grades.—Tunnel.—Salt creek.—Swambah creek.—Spanish trail.—Un-got-tah-bi-kin creek.—Colonel Burwell and Mr. Ross.—Tewip Narrienta.—Course of the Spanish trail to the west.—Wahsatch mountain reconnoissance.—Salt Creek cañon: its length, character, and grades for a railroad.—Wagon trail.—Entering Sevier River valley.—Moot-se-ne-ah Peak.—Mountains surrounding the Sevier River valley.—Mormon settlements.—Vegetation of the valley.—Sevier river.—Captain Gunnison's statement of the result of his explorations, for mail and military roads and for railroads.—Manner in which their duties were performed by the gentlemen of his party.—San Pete creek.—Road from Great Salt Lake to California.—Captain Gunnison's visits to Manti.—Cross the Sevier river.—Lake valley.—Un-kuk-oo-ap mountains.—Fillmore.—Sevier Lake valley.—Rabbit fences.—Return to the Sevier river.—Departure of Captain Gunnison and party to explore the Sevier lake.—Extract from his journal.—Party ascending the Sevier river.—Sand-hills.—River course.—Sage.—Cañon of the Sevier river.—Un-kuk-oo-ap mountains terminate.—First intelligence of the disaster to Captain Gunnison's party.—Departure of Captain Morris to the scene of the attack.—Stragglers.—Movement of the train and party to Cedar springs.—Return of Captain Morris.—Scene of the disaster.—Bodies of the slain.—False charges against the Mormons 66

CHAPTER VII.

From Cedar Spring, by way of Nephi, Payson, Palmyra, Springville, Provo, Pleasant Grove, Lake City, Lehi, Willow Creek, and Cottonwood settlements, to Great Salt Lake City—October 28 *to November* 8, 1853.

Pioneer creek.—Citizens of Fillmore.—Messrs. Call and Richards.—Express to Great Salt Lake City.—Courtesy and assistance from Mr. Call and Governor Young.—Papers and property recovered.—Kenosh's account of the murder.—Excitement of our men.—Course from the Coochetopa Pass to the Wahsatch Pass.—Character of the country from the Wahsatch Pass to Little Salt lake and Vegas de Santa Clara: its impracticability for a railroad.—Railroad following the Sevier river.—Western limit of the explorations of 1853.—Unobstructed passage from Sevier lake to Great Salt lake.—Return to Sevier river.—Appearance of Sevier River cañon.—Village of Nephi.—Payson.—Spanish fork.—Palmyra.—Provo.—Timpanogos river.—Western range of the Wahsatch mountains.—Line of Mormon settlements.—Supplies purchased.—Lake Utah.—Reference to Stansbury's Report.—Winter camp.—Condition of animals crossing the Plains.—Winter quarters at Great Salt lake 75

CHAPTER VIII.

General Summary of the line explored for the Pacific railroad near the thirty-eighth parallel of north latitude, from Fort Leavenworth (Kansas) to the Sevier lake, (Utah.)

Character and fertility of the Plains: timber, grass, rain.—Approach to El Sangre de Cristo Pass of the Rocky mountains.—Soil, cultivation, grazing, and water.—Mountain valleys.—Valley of San Luis.—Coochetopa Pass and surrounding country.—Grand River valley lands.—Roan mountains, and the country between Grand and Green rivers.—From Green river to the Wahsatch mountains.—Summit of the Wahsatch mountains.—Valley of the Sevier river and Sevier lake: its sterility.—Ingredients in the soil injurious to vegetation over large spaces.—Aqueous depositions unfavorably distributed and very limited.—Capacity of the country to contribute to the support of a railroad.—Railroad stations and posts.—Permanent water on the line.—Great scarcity of timber on the line.—Coal, where found.—Building stone.—Railroad practicability of the line.—Elevations, grades, sections, passes.—San Luis valley.—Coochetopa Pass and tunnel.—Altitudes and grades.—Pass and Coochetopa creeks.—Grand river section.—Blue to Green river.—Miry soil.—Stone for sub-structure.—Grades and bridges.—Rocky district west of Green river.—Grades from Green river to Akanaquint spring, White river, Clever creek, San Rafael river, &c., to the Wahsatch Pass.—Wahsatch Pass and tunnel.—Salt Creek cañon, grades, and character.—Sevier River valley, and passage through the Un-kuk-oo-ap mountains to Sevier Lake valley.—Further surveys, and existence of other lines near this.—Duties performed by scientific gentlemen of the party.—Climate.—Indian hostilities in Utah.—Further surveys will be made 79

CHAPTER IX.

Discussion of barometric observations and tables of altitudes and distances of the line explored from Westport, Mo., to Great Salt Lake City, Utah Territory; also, tables of simultaneous observations in, and data for profiles of, the mountain passes of the line—1853.

Page.

I.—Introduction to, and corrections applied in, barometric computations.—Table for horary corrections of observations.—Corrections for extreme air temperatures.—Comparison of field barometers with Dr. Engelmann's barometer at St. Louis, Missouri, both before and subsequent to the surveys.—Table of monthly mean observations at St. Louis, by Dr. Engelmann 89

II.—Barometric and meteorological observations, and table of altitudes and distances, for the profile of the line of survey from Westport to Great Salt Lake City 94

III.—Data for profile of Roubideau's Pass 108

IV.—Simultaneous meteorological observations at Coochetopa Pass 108

V.—Observations for a tunnel or deep cut in the Coochetopa Pass, allowing fifty yards as the width of the ridge at top 108

IV.—Table IV resumed 108

VI.—Data for the profile of the Coochetopa Pass, and declivities near its summit 109

VII.—Simultaneous meteorological observations at the pass and on the route followed across the Wahsatch range ... 110

VIII.—Data for the profile of the route followed across the Wahsatch mountains 111

CHAPTER X.

Geographical positions and distances travelled on the line of exploration from Westport, Mo, to Great Salt Lake City—1853.

I.—Letter from Mr. S. Homans, in charge of astronomical department 113

II.—Table of geographical positions from Westport, Missouri, to Great Salt Lake City, Utah 113

III.—Table of distances travelled, including those from point to point at which barometrical observations were made, on the route from Westport, Missouri, to Great Salt Lake City 115

IV.—Table of distances travelled on the line followed from Westport, Missouri, via Fort Riley, Kansas Territory, to Walnut creek 118

APPENDIX A.

Letters relating to the progress of the survey of the route near the 38th and 39th parallels, in charge of Captain Gunnison.

I.—Letter dated June 20, 1853, Camp, Shawnee Reservation, from Captain Gunnison to the Secretary of War, indicating the line which will be followed in crossing the Plains 119

II.—Letter dated August 22, 1853, Camp, Utah creek, near Fort Massachusetts, from Captain Gunnison to the Secretary of War, reporting the progress of the survey 119

III.—Letter dated August 22, 1853, Camp, Utah creek, near Fort Massachusetts, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey 120

IV.—Letter dated September 20, 1853, Camp 70, Grand river, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey 121

V.—Letter dated September 23, 1853, Camp 72, Bitter creek, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, forwarding a rude copy of the field-work of the survey 123

VI.—Letter dated October 29, 1853, Camp, near Fillmore, Utah Territory, from Lieutenant Beckwith to Colonel J. J. Abert, reporting the progress of the survey, requesting instructions, and indicating future operations 123

APPENDIX B.

Lists and explanations of the maps, sections, and illustrations of the reports of the explorations of Captain Gunnison in 1853, *and of Lieutenant Beckwith in* 1854 125

REPORT.

CHAPTER I.

From Fort Leavenworth, via Westport, Fort Riley, and Smoky Hill Fork, to Pawnee Fork; also, via Santa Fé Road to Council Grove and Walnut Creek.—June 15 *to July* 13, 1853.

Allusion to the death of Captain Gunnison and his assistants.—Extract from instructions from the War Department to Captain Gunnison.—Arrival at St. Louis, Kansas, and Fort Leavenworth.—Country from Fort Leavenworth to Westport.—Camp at Shawnee Mission, near Westport: its altitude above the Gulf of Mexico.—Arrival of the escort under Captain Morris.—Teamsters and mules.—First march.—Gentlemen composing the party.—Instruments provided.—The train: why used—Cedar creek: its timber.—Bull creek.—McClannahan and party, with stock for California.—Emigrants.—Division of party.—Route via Kansas river and Smoky Hill Fork.—Wahkarrussi bottom.—Timber.—Inviting appearance of the Kansas bottom: its fertility and railroad practicability.—Indian houses and grain fields.—Delaware guides.—Uniontown.—Rocky hills.—Storm.—Country approaching Fort Riley.—Crossing the Kansas.—Fort Riley.—Crossing the Republican Fork or Pawnee river.—Valley of the Smoky Hill Fork: its fertility and timber.—Sycamore creek.—Wagon road route from Fort Riley west.—Sand-hills.—Crossing Nepeholla or Solomon's Fork.—Short grass begins to appear.—Practicability of a wagon road to the Saline Fork.—Stream swollen: its passage and character.—First appearance of buffalo-grass.—Meadows of the Saline and Kansas rivers.—Smoky Hill.—Buffalo sign.—Lone Oak ford of the Kansas.—Railroad line thence to the Huerfano.—Sandstone ridges or bluffs.—Character of the soil.—Chalybeate spring.—First buffalo.—Passing from the waters of the Smoky Hill to those of the Arkansas river.—Sand-banks on the Little Arkansas.—Large fields of helianthus.—Indicated line for a wagon road west from Fort Riley.—Walnut creek.—Military parties and encampments.—Guides discharged.—Character of the country for roads of any kind.—Bridges.—Change in climate and character of the country.—Journal of the party following the Santa Fé road from Bull creek.—Black Jack creek.—Timber.—Bituminous coal.—Willow spring.—Stampede of emigrant horses.—Rock creeks.—One Hundred and Ten Mile creek.—Indian houses and fields.—Dwissler's, Dragoon, and Prairie Chicken creeks.—Elm, Bluff, and Big Rock creeks.—Council Grove.—Timber and fields of corn.—Civil and military parties en route for New Mexico.—Incident in Governor Merriwether's life.—Diamond spring.—Lost spring.—Scarcity of timber and monotonous character of the country.—Snipe.—Cottonwood creek.—Annoyance from flies and mosquitoes.—Turkey creek.—Miserable water.—Little Arkansas.—View of the Arkansas river bottom.—Owl and Cow creeks.—Change in the character of the soil and vegetation of the country.—Dog towns.—Sand-hills.—Arkansas river.—Kansas, Osage, and Sac Indians.—Walnut creek.—Suffering from mosquitoes.—Site for a military post.—Timber on Walnut creek.—Pawnee Rock.—Ferruginous sandstone.—Ash creek.—Grass and soil.—Pawnee Fork.—Timber.—Altitude of camp on Pawnee Fork above, and distance from that near Westport.—Osage and Kansas Indians.

SIR: In order that you may be put in possession, at as early a day as practicable, of the result of the investigations of the exploring party organized under your order of the 20th of May, 1853, by the lamented Captain J. W. Gunnison, of the corps of Topographical Engineers, who was barbarously massacred by the Pah Utah Indians, on the 26th of October, on the Sevier river, and near the lake of that name, in the Territory of Utah, while in the performance of the duty assigned to him, I deem it my duty, as his assistant, to report the same—a duty upon which I enter with unusual diffidence; the more so as it is not contemplated, by the instructions referred to, that this duty should devolve upon me. There being with the party, however, no other person upon whom it can be devolved, and the importance of its being submitted within a specified time, seems to render this report necessary. But I should neither do justice to the memory of the dead, nor to my own feelings, in entering upon a report of the labors performed in their respective departments by those who fell in the fatal affair referred to above, (which has been before, however, officially communicated to you,) were I thus to pass it by. With Captain Gunnison

also fell, of the scientific gentlemen of the party, Mr. R. H. Kern, an accomplished topographer and artist, and Mr. F. Creutzfeldt, botanist. Of the performance of his duties by my late commander, associate, and friend, it may not be proper that I should speak; yet I take pleasure in giving expression to the admiration of all their associates commanded by each of these gentlemen, in his respective department, up to the time of his death, by the active, faithful, and energetic performance of his duty. And we were in a position, encountering together as we had for so long a period, the labors, fatigues, privations, and exposures incident to an undertaking in which, from day to day, every quality of the mind and heart of one's associates is thoroughly developed, in which you, Sir, are well aware that the strongest ties of esteem and friendship are formed and cemented; and in severing the ties thus formed, not only has this exploring party, and the department of science to which each was attached, suffered a severe loss, but the country itself has reason to mourn the loss of such experienced and energetic officers and citizens. Besides these, Mr. Wm. Potter, a citizen of Utah Territory, a resolute and determined man, who had joined the party as guide but a few days before the disaster, was killed, together with one employé, John Bellows, and three private soldiers of the escort, belonging to the regiment of Mounted Riflemen.

The following extracts from your orders and instructions, above referred to, will explain the duties assigned to this party:

"Under the 10th and 11th sections of the military appropriation act of March 3, 1853, directing such explorations and surveys as to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean, the War Department directs a survey of the pass through the Rocky mountains, in the vicintiy of the headwaters of the Rio del Norte, by way of the Huerfano river and Coo-che-to-pa, or some other eligible pass, into the region of Grand and Green rivers, and westwardly to the Vegas de Santa Clara and Nicollet river of the Great Basin, and thence northward to the vicinity of Lake Utah on a return route, to explore the most available passes and cañones of the Wahsatch range and South Pass to Fort Laramie.

"The following instructions relative thereto are issued for the government of the different branches of the public service:

"I. The party for this exploration will be commanded by Captain J. W. Gunnison, Topographical Engineers, who will be assisted by First Lieutenant E. G. Beckwith, Third Artillery, and such civil assistants as the Secretary of War may approve.

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"VI. The party being organized, will collect the necessary instruments and equipments. It will then repair with the utmost despatch to Fort Leavenworth, and with the escort proceed to the Huerfano river, making such reconnoissances from the Missouri river as will develop the general features of the country, and determine the practicability of a railroad across the plains, and its connexion with the eastern lines of commerce.

"The more minute reconnoissance will continue up the Huerfano into the San Luis valley, and thence through the most eligible pass to the valley of Grand river, and westwardly to the vicinity of the Vegas de Santa Clara, and thence, on the most advisable route, either along the Nicollet river, or to the west of the ranges of mountains bordering that stream, into the basin upon the route to the Great Salt lake; thence to Utah lake, and through the Timpanagos cañon or other passes, and across the Weber and Bear rivers, by the Coal basin, to Fort Laramie.

"Competent persons will be selected to make researches in those collateral branches of science which affect the solution of the question of location, construction, and support of a railway communication across the continent, viz: the nature of rocks and soils—the products of the country, animal, mineral, and vegetable—the resources for supplies of material for construction, and means requisite for the operation of a railway, with a notice of the population, agricultural products, and the habits and languages of the Indian tribes. Meteorological and magnetic observations, the hygrometrical and electrical states of the atmosphere, and astronomical observations for deter-

mining geographical points, shall be made, in order to develop the character of the country through which the party may pass.

"On or before the first Monday of February next, Captain Gunnison will report the result of his investigations."

Agreeably to these instructions, Captain Gunnison arrived at St. Louis on the 4th of June, and proceeded immediately to procure the necessary supplies and outfit for the party, in which he was greatly aided by Colonel Robert Campbell, of that city, whose well known courtesy, though severely taxed, was freely extended to us. These were shipped on the 9th, and landed on the 15th of June, at Kansas, which is near the western border of the State of Missouri, and about a mile and a quarter below the junction of the Kansas river with the Missouri, in charge of Mr. Kern, who was to transport them to some point suitable for a "fitting out camp," while Captain Gunnison, whom I accompanied, proceeded to Fort Leavenworth on duty relating to the escort of mounted riflemen which was to accompany the party. We were surprised, on our arrival in the afternoon, to find that no orders had been received at the fort, relating to the escort, for it was known that they had been issued some time previous. The opportune presence, however, at the post, of General Clark, commanding the department, obviated any delay on this account, as, after proper statements and explanations, he gave the necessary instructions for the escort to be equipped and fitted out in anticipation of the receipt of the orders referred to. At an early hour on the following morning we left Fort Leavenworth, which is situated on the right bank of the Missouri river, in the Indian territory immediately west of that State. The day was fine, and the high, beautiful rolling prairie from Fort Leavenworth to the Kansas river, a distance of twenty-two miles, was covered with luxuriant grass, and profusely sprinkled with flowers. We passed some fine Indian farms of the Delaware nation, and respectable herds of stock grazing near the road. The creeks and rivulets were lined with timber, in which oak largely predominated, extending back from the Kansas river, by our road, three or four miles. The descent to this river is abrupt at Delaware, a trading post among this people, where we crossed by a ferry, kept on the north side by themselves and on the opposite by the Shawnees, to whom the territory belongs. Crossing a timbered, sandy bottom of half a mile in width, our road led up a steep hill, finely timbered, and again through fine Indian farms to the open prairie, in all respects like that of the morning. Arriving near Westport we fell in with our camp, and with pleasure alighted from the wretched stage to begin our arduous march. Our encampment was some five miles from Westport and the western line of the State of Missouri, selected by Mr. Kern in a fine grove near a spring, and surrounded by fine grass and an open prairie, and in the midst of the various Shawnee missions, which appeared well. The approximate elevation of this point above the Gulf of Mexico, as indicated by our barometers, is 990 feet, or 615 feet above low-water mark at St. Louis, as deduced from Dr. Geo. Engelmann's valuable observations at that place. kindly furnished to aid the meteorological discussions in this report. The purchase of mules and horses and employing men suitable for the expedition occupied several days at this camp, and the breaking in of the teams and teamsters as many more, during which our camp was only moved to secure grass when the animals had fed it down near us. On the 20th, Brevet Captain R. M. Morris, first lieutenant, and Second Lieutenant L. S. Baker, with some thirty non-commissioned officers and men of the regiment of Mounted Riflemen, with the necessary subsistence train, joined us as escort. The 21st of June was spent, as the previous two or three days had been, in breaking in wild mules; no others could be obtained on short notice, so large had been the demand by emigrants going west of the mountains. Nor were we more fortunate in procuring capable teamsters, the large trains which annually cross the plains having preceded us; but by industrious drilling, and replacing incompetent men by the trial of the skill of others, we deemed ourselves at evening in a condition to move forward the following morning. But at an early hour it began to rain in torrents, and continued during the day, so that it was impossible to do more than to harness up a few of the wildest mules to habituate them to their labors. On

the 23d the creeks and branches were still swollen by the rain of the previous day, and the roads slippery and soft. The advance, however, was ordered, and we pursued the usual Santa Fé road for eight miles, and encamped for the night on Indian creek, a small timbered stream; the character of the country being that already described—as beautiful and fertile rolling prairies as the eye ever rested upon.

The party, (the escort having been already mentioned,) which this day made its first marching essay for the exploration of the Central Pacific Railroad route, was composed of Captain J. W. Gunnison, Topographical Engineers, commander; First Lieutenant E. G. Beckwith, Third Artillery, assistant; Mr. R. H. Kern, topographer and artist; Mr. Sheppard Homans, astronomer; Dr. James Schiel, surgeon, geologist, &c.; Mr. F. Creutzfeldt, botanist; Mr. J. A. Snyder, assistant topographer, &c.; and Mr. Charles Taplin, wagon-master; besides the necessary teamsters and employés for the performance of the labors of the route.

The party was provided with the following instruments, viz: two sextants, two artificial horizons, one theodolite, two Schmalcalder's compasses, two spy-glasses, two surveyors' chains, two Bunten's barometers, two aneroid barometers, two thermo-barometers, one hygrometer, one box chronometer, one compensating balance watch, two viameters, and one grade instrument, besides thermometers and small pocket-compasses. Of these one of the Schmalcalder's compasses proved imperfect and worthless, as did the thermo-barometer which was graduated to high altitudes; and we were soon above the scale of the other, so that these instruments were of no use to us.

The civil engineer, whose services had been engaged by Captain Gunnison for the exploration, fell sick on the road before reaching St. Louis; and two barometers which he had in charge were necessarily left behind, as the season was already too considerably advanced to admit of further delay, especially as we were already well supplied with these instruments, should they prove good and no accident befall them.

The train consisted, for the party and escort, of eighteen wagons; sixteen of which were six-mule wagons, an instrument carriage drawn by four mules, and an ambulance by two horses, which were, however, changed for four mules before we had reached the mountains, the horses being broken down.

This method of transportation was determined upon in order, should the train pass successfully over the route, to demonstrate its practicability, at least for a wagon road.

The road to-day followed the general level of the country, leaving the Kansas river bottom (a favorable route for a railroad from the Missouri river) to our right. Nine miles from Westport we passed a finely wooded creek, near which was observed a fine spring of cool water, and near it a small cultivated field.

June 24.—A cool bright morning, with the thermometer at sunrise at 52° Fahrenheit. We were at an early hour again on the Santa Fé road, and arrived at 10 a. m. (not without several accidents to our loaded wagons, resulting in nothing serious, however,) at Cedar creek, which has more water than Indian creek of our last camp, but is skirted with less timber. This creek has worn for itself a small ravine in the limestone which underlies this section of country, and which is here left in escarpments on either side of the stream. In this narrow ravine is the timber of the border, which can therefore be seen only at a short distance on the prairie. I observed among it oak and walnut, and cedar is said to appear a few miles below and continue to its mouth. The marked feature of the country to-day, as heretofore, is the graceful grassy swells which extend as far as the eye can compass, and are lost in the blue line of the horizon. The latitude of this camp, as determined by Mr. Homans, is 38° 52′ 41″.

June 25.—Following the Santa Fé road, we encamped this morning, at 10 o'clock, on Bull creek, the counterpart of that at our preceding camp. The road has thus far been very fine, following the general level of the country between the waters of the Kansas and Osage rivers. The country to-day was more than usually level, and the timber less abundant—if, indeed,

abundant can be properly applied to so scarce an article. Quite far to the north and west, twenty or twenty-five miles, we at one time had a view of the Kansas valley, which appeared well timbered.

Mr. McClannahan, (a gentleman whom we had met on the steamer in coming up the Missouri river,) who had been favorably impressed with the reputed character and direction of the route we were to explore, and who was on his way by the Platte and Sweetwater route to California with a large flock of sheep, which had already reached the Missouri at St. Joseph when we met him, changed his route and here came up with us. He was accompanied by his partner, Mr. Crockett, and by two brothers, Messrs. Burwell, with a fine herd of cattle, also for the California market. Besides these, he was soon joined by two gentlemen, Messrs. Ross, with their families, destined for the land of gold. The lateness of the season, and the vast amount of stock which had passed up the Platte, sweeping away all the grass, had determined these gentlemen to follow our trail; believing that it would not only be found practicable, but shorter and more abundantly supplied with grass than any of the usually followed routes, and that they could easily keep near us, rendering their passage comparatively safe through the various Indian tribes to be passed to the east of the Great Basin.

It had been Captain Gunnison's intention, till last night, to turn off here with his party from the Santa Fé, and follow for a short distance the emigrant road to Salt lake and Oregon, and thence up the Kansas on its south side, beyond the Big Bend of the Arkansas river, taking nearly a direct course for the mouth of the Huerfano. But after much inquiry about the country, of Indians and others who know something of it, and a long conversation with Major Fitzpatrick and Mr. Wm. Bent, whom we met here, he determined to divide his party at this point, and with a few men, an instrument wagon and a few pack-mules, to proceed himself partly by this route, directing me to proceed with the train and balance of the party, by the usual Santa Fé road to Walnut creek, and there await his arrival. Near our camp were the dwellings and farms of a few Christianized Indians.

June 26.—Captain Gunnison and party, consisting of Mr. Kern and Mr. Homans, also a teamster and a packer, with Captain Morris and a few of his men as an escort, moved off at the usual hour, 7 o'clock, by the Kansas river and Smoky Hill Fork route. The journal relating to this part of the survey is taken from Captain Gunnison's notes, and much of it is an extract from them: "Contrary to the general rule, (it being Sunday,) we leave for Wahkarrussi this morning, having learned that the Indians are assembled there for church service or meeting, and start early to witness the occasion, never having been at one of their missionary gatherings. Lieutenant Beckwith also moves off on the Santa Fé road—our men and animals having had nearly all the week to rest.

"At eight miles we came to a house and field, and descended a hill half a mile farther on, where we crossed a fine creek which we had been nearing on our left for two miles. This creek is fringed by a dense growth of oak, elm and poplar. Passing over a fine plain for four miles, we crossed another stream which has beautiful groves along its sides, of red and white oak, sycamore and locust. Young hickory is also springing up along its banks, and it is to be hoped that fires will be kept off until it can contend successfully for existence, and add to the beauty and usefulness of this fertile country. After a ride of 14.89 miles, we encamped on the southern side of the Wahkarrussi, a tributary of the Kansas river. Half a mile above the crossing, which is a ferry at high water, a sandstone several feet thick, in horizontal layers, is cut through by the creek.

"*June* 27.—At 7 o'clock we were crossing the rich, alluvial bottom of the Wahkarrussi. It is one and a half miles wide, covered with rich grasses. To our left, and on the other side of the creek, is the Wahkarrussi mound, a hill that is a conspicuous land-mark for a great distance. Yesterday we were all day steering to the right of it. On the north side it is wooded from the brow to the stream. Five miles out we ascended the limestone ridge between the Kansas and

Wahkarrussi, and had a grand panoramic view of the adjacent country. The forest at the junction of the streams, and on both sides, will furnish oak, hickory, walnut, and other timber, for many miles of railroad; and the level bottom of the Kansas appears to advantage, inviting the theodolite and level of the engineer on its E.N.E. and W.S.W. course, for the track of the Central Pacific railroad. The fertility of these valleys, on either side, capable of supporting great numbers of people, is too obvious to mention.

"At a mile from the escarpment of limestone rock, on the left-hand side of the road, there issues a fine, cool spring, a curiosity on the top of this narrow ridge, one hundred feet above the bed of the stream. At sixteen miles from camp we came to a wooded dell, called Coon Point, the proper place to take wood for a march to Big spring. Twenty-one miles along the ridge brought us to this spring, which is on the north side of the road, and two hundred yards from the main track. It is situated in a hollow, and there are several small jets from the bank. Indeed, in all the ravines we entered, a short distance from the brows on either side, water can be had by clearing out the oozy mud at the edge of the thin strata of limestone which crop out. Some portions of the road to-day were covered with loose stones.

"At 11 a. m., barometer 28.80; thermometer 81°. At sundown, barometer 28.70; thermometer 77°; dew-point 70°.

"*June* 28.—The water of Big spring seems to have affected badly more than one of the party. The wind blew a gale all night, and this morning we had a little rain, and it remianed cold and cloudy all day, with lightning in the south. The country was very rolling on the higher table-land, from which we descended shortly after leaving the Big spring, and steered our course towards a hill fifteen miles from camp, and made, opposite to it, Stinson's trading-house, on Shunga Munga creek. Here the road to California branches off to the middle ferry, which is three miles to the northwest. The valley of the Kansas was visible a part of the way; or rather the Kansas bottom, for people in this region make a difference in this matter. The level meadow, or prairie, in which the river winds from hill to hill, is called the 'bottom;' and all the land, hill and meadow, drained by the stream, is called 'the valley.' The river is said to impinge frequently against the bluff hills on the south, in this part of its course. We nooned for half an hour at a small creek, heavily wooded, by a fringe one hundred yards wide, with the usual varieties of timber. On the west side are boulders of granite, serpentine, and red quartz rock. At 3 o'clock p. m. we arrived at Mission creek, where there are all the requisites of wood, water, and grass, for encampments, for a long time to come. Day's march twenty-three miles. Some Indian log-houses were passed at a distance to the right; and fine fields of corn, wheat, and potatoes, on Shunga Munga creek, give promise of what can be expected when these rich lands are cultivated 'in the sweat of the brow,' according to the dispensation of the order of nature. Just at our supper-dinner, Entho-kipe and Wah-hone, the guide and hunter of the Smoky Hill Fork trip, came to camp. They have been waiting two days on a creek two miles ahead, and were starting to look us up. The guide speaks a little English, but it is difficult for him to understand us; he has therefore brought another Delaware with him, who speaks English well. As soon as they had satisfied their appetites and taken a stock for to-morrow, they returned to their camp to await our arrival. I have this evening a severe attack of my old illness on the Plains.

"*June* 29.—Very cloudy and warm. Thermometer at 6 a. m., 62°. I passed a bad night. At Uniontown, to which we came after a ride of 7½ miles, there is a street of a dozen houses, where the traders reap their harvests at the time of the national payments. We could get no information about our route here. At Six Mile creek we stopped a few minutes only, as it began to rain. We have here an abundance of wood. At fourteen miles we crossed a fine, swift stream from southwest, 100 feet across, and averaging one foot in depth; timber and grass abundant. Il-a-heek-con-a-sa is the Indian name of the creek. Thence for three miles we travelled westwardly on a beautiful bottom which borders the stream. The prairie is purple with rich flowers,

variegated with yellow. We made but 18¾ miles to-day; leaving the road at Uniontown, and deflecting from the Kansas a little to the left, following a trail. The Indians, viz: Jno. Moses, guide; Wahhone, hunter; and James Sanders, interpreter, joined us, and began their functions of guides when we left the road. It is necessary to take three, in order that they may be strong enough to return safely. Our camp is on a branch of Il-a-heek-con-a-sa.

"*June* 30.—It rained all night, making the roads heavy; the prairie giving under the carriage-wheels. In about 3½ miles we came to another branch of the Il-a-heek-con-a-sa, and had an hour's delay in cutting a crossing; and two miles farther on we had another delay of a similar character. There is the usual strip of woods on these branches. We had at one time a view of the Kansas valley, four miles distant. Crossing another branch, which is at times a torrent, but now a mere rill, we ascended a ridge by gentle ascents at 12.68 miles from camp, where we had a magnificent view of the Kansas valley to the northeast. We then descended quite abrupt hills to ——— creek, which is about twenty feet wide, and well wooded along its margin. Here we were detained an hour, and then began another ascent, which soon brought us again to the vision of the beautiful Kansas valley, and the hills, with clumps and rows of trees, sloping up on the north side of the river. We experienced much difficulty in crossing gullies on our route, for it is without a trail, and Ent-ho-ki-pe takes his 'bee-lines' across the country. This has been a hard day's work for the carriage mules; the ground soft and yielding, and the hills, though gentle of ascent, are long, and in many places rocky. It looks very inviting to descend to the Kansas bottom; but the streams cut deep chasms in the alluvion, rendering it almost impossible, without bridges, to cross them.

"*July* 1.—This morning displayed a sorry-looking camp. There was a storm of three hours' duration during the night, such as the Plains only can exhibit. We are without tents, having only three tent-flies for sixteen men. These flies, stretched over poles, leave the ends open, affording but little protection against driving rains. The thunder-storm burst at midnight in fury upon unprepared, or, at least, unprotected individuals. One fly fell prostrate over three men, and in the darkness, lighted by fitful flashes of intense lightning, which was as blinding as the darkness itself, they could not re-erect their frail tenement, but quietly endured their drenching. We ascended the ridge again for 2½ miles, when a band of half a dozen antelope, for the first time, greeted our sight on a distant summit. We then began a long descent, and in three miles were in the valley of White Oak creek, which is formed by several branches to our left, at the junction of the two principal of which we crossed. These little branches are difficult to cross, and they occur frequently. We then ascended, perhaps 300 feet, to a dividing ridge, which we followed for seven miles; and then, descending to a branch of the last creek, encamped at 4 o'clock p. m. Water is found in pools, and a spring issues from under an escarpment of white limestone 100 yards from camp; but we are nearly without wood. The road on the hills has been hard for the cattle, on account of the sharp, pebbly limestone scattered thickly over the ground. The rock splits into fragments by the effects of the sun and rain, and having no attrition, these fragments are sharp and flinty in appearance We have unintentionally left the Kansas far on the right, probably striking across the bend opposite the mouth of the Blue river.

"*July* 2.—We had another rainy night. This morning we travelled northwest for 4½ miles, and encamped. Captain Morris left for the Republican fork of the Kansas, northeast; but after four hours' travelling, returned, the guide having mistaken Blue river for that stream. We again moved forward, and crossed No-Nome creek, as Ent-ho-ki-pe calls it—an operation of no small labor. The escort, in endeavoring to follow, mired one horse and injured another, by which they were so long detained, the wagon having gone ahead, that they could not follow its trail after dark, and they therefore slept on the hill all night, a mile from camp, without food or water. The road wound up the high hills to the top of a dividing ridge between two creeks, affluents of the Kansas, and we had a fine view of the groves on that river, and soon came in view of the long-desired fort on the Republican. But we had a frightful hill to descend, and just

at dark arrived on the brow of the bluff, where trees whose tops are nearly on a level with us are growing in the valley of the creek. Here we encamped, or rather laid down.

"*July* 3.—The escort came in at sunrise, and we crossed the Mahungasa creek, which is 100 feet wide and 3 deep, with a swift current, and is the largest creek we have yet crossed. It is rightly named Big Stone, for at the ford we found its bed covered with boulders. In two and a half miles we arrived on the bluff opposite the new fort on the Pawnee river, (or Republican fork,) and prepared for the rest of Sunday. We communicated with our friends at Fort Riley. The fort is to be built of white limestone, quarried or lifted from the escarpment of the bluff; and the soldiers' barracks, in a half-finished state, already make a fine appearance from a distance.

"*July* 4.—We were notified by a rifle report, at daylight, of the arrival of the national anniversary. After numerous discharges of fire-arms, we started for the Kansas river for the purpose of crossing to the opposite side. This was determined upon because the north side of the Smoky Hill fork had not been examined, while there have been several surveys made of the south side. An India Rubber ponton, procured from Fort Riley by the kindness of Major Ogden and Lieut. Sergeant, acting assistant quartermaster, was placed too low for our light vehicle, and it upset while floating across—a small incident for the 4th of July. Our horses were crossed by swimming, and we arrived about noon at the fort. This is placed at the junction of the Pawnee river with the Kansas, and not in the forks of the Smoky Hill and Pawnee, as we were before informed. There is a noble spring near the site, which appears to be well chosen at the head of navigation on the Kansas, from whence supplies can be sent to the posts in the Indian country and to New Mexico. A ferry across the Pawnee river (as the officers call the Republican fork) conveyed our wagon over; which was a difficult operation, however, but safely accomplished under the direction of Mr. Homans, while I was indulgent enough to myself to accept the invitation of Captain Lovell, commanding, to dine at the officers' mess. Lieut. Sergeant, acting assistant quartermaster, &c., did all that he could to supply our wants, and started us with fresh supplies. After a short nooning, I proceeded 7.59 miles to a spring in the bottom, near the Smoky Hill, passing one of delicious cool water, out from the bottom and under the bluff a half mile back, but where there is, unfortunately, no wood. After having crossed Pawnee river we entered upon the bottom in the forks, which is a mile and a half in width, and of rich alluvial soil. In seasons when not overflowed—and it is believed it rarely is covered with flood—it would produce fine fields of hemp. For two miles from this bottom, the ascent is so gentle as hardly to be discernible. At the junction of the two forks there is a body of large cotton-wood, with elms intermixed; and the ravines on the hill-sides are also well filled with small oaks, which are useful for fuel, but few are suitable for building purposes. The valley of the Smoky Hill fork is on our left, and is from one to two miles wide, with the circuitous river-bed in it fringed with poplars, presenting a lovely picture, and is very favorable for the construction of a railroad.

"*July* 5.—Leaving the beautiful spring at which we had encamped, we crossed the bottom and skirted along the hills S. 75° W. for 2.26 miles, and then, continuing the same course, ascended the slight undulation which slopes up from the bottom, until we came to Deep or Sycamore creek. Here we found the water too deep to cross, and turned north two and a quarter miles to the first ripple, where, with a little cutting and aiding down the wagon, we crossed safely; and after ascending for four miles, we passed again S. 72° W. to the bottom, where we found the slope of the hills very fine sand and heavy pulling. Deflecting to S. 80° W., we struck off along the beautiful flat, which reminded us of the Nebraska. It is here about five miles wide, the Smoky Hill fork skirting the south side. Wagons from Fort Riley should keep on the brow of the slope from Pawnee river to Sycamore creek; then passing over the point to cut off a bend, they should follow the bottom land, near the foot of the slope, for seven miles, to the creek upon which we are encamped. These creeks can be easily bridged. Coming to a creek with little water, but a deep eastern bank, we lowered the wagon down it and made camp just before dark. Distance by route, 22.50 miles.

"*July* 6.—Thermometer at sunrise 70° Fahrenheit; barometer 28.91. We continued our course S. 70° W. along the flat. The hills are composed of fine sand, and would become heavy roads for loaded wagons. A ride of ten miles brought us to Nepeholla or Solomon's fork: the road along the base of the sand-hills is good, the hills themselves being of too loose sand for wagons. The river we found swollen by a flood at least eight feet above low water. There was no alternative but to look around for material with which to construct a raft—a matter of some account, as we were only provided with two dull axes. But with two dead trees, already water-soaked, we laid the basis of timbers, and bound on these such dry small willows as we could find; and by making some twenty trips we got safely over. The carriage body being tight, floated across easily. The Delawares rendered great service, swimming about, carrying ropes, and towing horses over all the afternoon. They seemed to delight in the watery element. The grass is becoming shorter, and the timber less in quantity and varieties, the cotton-wood being the prevailing tree, and this is confined in patches to the margins of the creeks.

"*July* 7.—A cool, delicious morning, the river still rising. We travelled S. 70° W. across the level plain, between the Kansas and Nepeholla, for four miles, to the foot of a dividing slope, opposite which, on the south side of the Kansas, is a square butte. A wagon road could be well maintained on this meadow all the year. After riding seven miles we struck the Saline fork in the meadow. This stream is also swollen by a flood, and looks like the boiling Missouri. Continuing our course for two miles, we halted on one of the bends of this stream and cut two dry cotton-wood logs, which we lashed to the sides of our wagon wheels, and thus made a ferry-boat of our carriage. With this we ferried over the stream, which is 150 feet wide and 9 feet deep, with a rapid current. The guide represents it as being usually 20 feet wide and 2 feet deep. It is surprising to see such a freshet without any visible cause. Stretching away to the west for some hundreds of miles, the river has no doubt received the product of heavy rains. The Nepeholla rose six inches yesterday, and this river as much during the seven hours we were most laboriously engaged in crossing it. Without our Delawares, we could not have effected this work. They plunged into the boiling current with the ropes on their necks, and stretched them across the streams for us, and then passed along the same to slip the noose over the knots—for we have only our picket-ropes for this purpose, which being tied together, were long enough to pull back and forth, which greatly facilitated operations, and without which we could have done nothing to advantage. Our hunter killed a noble fat buck, which, with a cup of black tea for supper, soon refreshed us from one of the most fatiguing days we have yet experienced. Plats of buffalo-grass appear occasionally, and we soon expect to be on the trail of these animals.

"*July* 8.—We started this morning over the grand meadow of Saline and Kansas rivers, bearing S. 45° W. between the two streams, which at this point diverge rapidly. The Kansas has a trend as you go up its stream, to the southward, passing around the famous Smoky Hill, which was full in sight, with its azure hue, on the east of it. This hill has given the name to this part of the Kansas, but our guides do not know it by the name of the Smoky Hill fork. The hill may be 100 feet in elevation above the plain. We kept our course up a branch of the Saline, south-west, on a plain so gently rising that the ascent was scarcely perceptible, and nooned on its banks, 13.50 miles from our last night's camp. Signs of buffalo are very numerous, and their trails quite fresh. A party of Pottawatomies has preceded us, and probably driven them farther into the buffalo ranges. In fifteen miles we came to ferruginous sandstone ridges on either side of our course, which is remarkably direct, following a plain valley in which a creek meanders.

"*July* 9.—Gradually ascending this branch, it soon brought us near the main stream; and by passing a low divide we came into the main valley, where there is quite a large quantity of wood, and, at this season, water. Water in pools continued nearly to the summit of the next divide; beyond which, in the distance, are oak and cotton-wood trees of small growth, on a stream running southeast into the Kansas. At half-past 10 o'clock we reached this river, which we found to be falling, having been eight feet higher than at present within two or three days. We came to a

good ford, in a low stage of the water, which we call the Lone Oak ford, as there is here a remarkable solitary oak tree in the bottom. We remained here till 1 o'clock, and then passed over, the wagon body just clearing the water, and ascended the slope for a mile, but turned down again to cross a creek near the bottom. From the top of the ridge we discovered a lone butte, S. 33° W., and another S. 25° W. Our course bore thence over the heads of a creek well wooded with a stunted growth of ash, walnut, oak and cotton-wood. Here we found the choke-cherry ripe. Keeping up the ridge for some time on the right of this creek, we found no signs of passing over to Walnut creek, as promised by our guides, and therefore we turned a little more westwardly and down the slope to a nearly dry creek. On the way we passed a small spring coming from under a sandstone bluff, but preferred to go a half mile farther to the creek, on which the walnut tree prevails, interspersed with oak, elm and cotton-wood. At the place where we crossed the Kansas the valley is not more than a quarter of a mile wide; and though it widens in places above, as we could see from the hills, the course of the plain is more winding than below, and probably it will be found advisable in the construction of a railroad to deflect to the mouth of the Huerfano from near this point of the river. It will, however, require minute exploration to find the best point and to obtain the best grade for a railroad, as the creeks coming in from the south make deep indentations in the rolling prairie. The rise from the Kansas is not abrupt; the hills sweep down gracefully, and no serious difficulties are in the way of a good track. But the timber has become more scarce and dwarfish. The hills are composed of a hard red clay, with occasional beds of gray or white clay. They are sometimes covered with fragmentary sandstone; and escarpments at other places show the stone in situ and stratified. We here discovered a very cool spring, the water appearing chalybeate, from which we hope for some happy effect upon several persons of the party who are slightly ill. The spring bursts up in considerable volume near the dry bed of a creek.

"*July* 10.—Remained in camp to rest man and beast. In the afternoon we were visited by one of those violent rain and wind storms which are well known to travellers of the Plains. The ground was soon covered an inch deep with water. The dry bed of the creek flowed with a strong muddy current, which continued till we left on the following morning. We gathered wild cherries, (choke,) currants, and gooseberries, and the wild grape-vines were loaded with green fruit.

"*July* 11.—Starting at 6.30 a. m., we had a wet, foggy morning till 7. In a few miles we came to the summit of the ridge between the waters of the Kansas and Arkansas rivers. Here we had a broad, level country before us, and in the distance a ribbon of trees was visible on Cow creek, to which we gently descended. The creek is swollen by yesterday's rain to twelve feet in width and two in depth in the centre. Barometer's reading at 9 a. m., before passing the summit, 28.237; thermometer 80°; and on the plain, at 11 o'clock, after passing, 28.276, thermometer 89°. Here we saw the first buffalo, which the hunter killed. It proved to be a bull feeding alone, but as he was pretty fat we had some of it cooked for dinner. At 12 m. we arrived at the 'Sand-Banks,' which border the northwest branch of the Little Arkansas. This stream is very muddy and swollen by recent rains, being now forty feet wide and two feet deep in the centre. We had now traversed, for fifteen miles, a plain with gullies cut deep by the branches of Cow creek—our general course having been S. 50° W. The rise from camp to the summit was very gentle, and it was so slightly marked that it was not observed till we had passed it some distance. The 9 o'clock barometrical reading given above will determine the altitude of this summit-level with accuracy. After nooning we crossed the creek below the drifting sands, which are on the south side, and extend one mile in length and a half mile in breadth; we then crossed them diagonally, and continued on uneven sand-knolls, which are fixed by vegetation, for a mile. A variety of shrubs grow on these sand-hills, among which is the wild plum, very much dwarfed, but loaded with unripe fruit. We then descended slightly to a flat, which is clayey and too low for a road for wagons. At a short distance from the base of the knolls the helianthus grows densely,

extending northwest over a field of several square miles in extent, with grass and saline plants intermixed. We attempted to cross this sun-flower field, but were very soon forced back to the high ground, for the water was rushing over it, being backed up by the rise of a creek five miles before us, showing the extent of yesterday's rain. After travelling twenty-nine miles we came upon a torrent of muddy water, running in banks too deep and sharp for crossing without labor, and, in our vicinity, too deep also to ford, and we therefore encamped much fatigued by the day's work. The quartermaster's road from Fort Riley should strike higher up the Kansas, and cross the ridge to the west of our line.

"*July* 12.—The Arroyo creek had fallen so much that we passed safely over it this morning, and afterwards met two Indians hunting buffalo. From them we could only learn, by signs, that their people were encamped over the next ridge, on Walnut creek. Crossing Mosquito creek in two and a half miles, which is a branch of Cow creek, and is dotted here and there with ash, elm and cotton-wood trees, we came in a short time in sight of the elms and ash of Walnut creek. It is difficult to cross this creek with wagons above the ford for the Santa Fé road, which is near its mouth. We crossed over, however, and followed down the west side, and found the party under Lieutenant Beckwith in camp, waiting for us since the ninth instant. Here we also found Brevet Major Johnson, sixth infantry, in command of a camp, being about to build a fort upon the creek; the fort on the Arkansas, 100 miles west, from whence his present stores are received, being about to be abandoned. In the night Colonel Sumner, Majors Morris and Hagner, returning from New Mexico with an escort, arrived at camp. Our Delaware guides were here discharged. I furnished for Major Ogden, A. Q. M., a description of the country his guides had shown me from Fort Riley, with the distances travelled, and advised him that with proper bridges a fine and remarkably level track could be found thus far on our route for the location of any kind of a road. Of course, the relative merits of the two sides of the Kansas I cannot discuss. The four bridges on the main streams would be an item of cost; but if Fort Riley, on the Kansas, is at the head of the steamboat navigation, then this is the proper way for a route to New Mexico south or north, for wagons or for a railroad. The character of the country changes materially in soil, climate and productions at the ridge between the Kansas and Arkansas rivers. Some buffalo-grass, scattered in patches, was noticed after crossing the Saline; now it is the prevailing grass."

ITINERARY OF LIEUTENANT BECKWITH'S PARTY, WHICH FOLLOWED THE SANTA FÉ ROAD.

The following extracts from my own journal descriptive of the country which I traversed on the Santa Fé road, on a line some 20 or 30 miles distant, and nearly parallel with that followed by Captain Gunnison, are added, to show that the fertility he has described along the valley of the Kansas river and its main tributaries, extends far back over the rolling prairies towards the sources of the small streams and rivulets of the country, and that its general character is such that a railroad may be carried over it in any desired direction.

June 26.—As stated by Captain Gunnison, we moved out of camp as his party set off on the route of the Kansas river and Smoky Hill fork, and nine miles out passed Black Jack creek, in which there was but little running water, and, skirting its banks near the crossing, a few scattered trees; and generally in the early part of the day timber was very scarce, but afterwards became more abundant a few miles from the road, and at times extended quite up to it. We had at one time a beautiful view of a finely-wooded valley to the south; and later, of one to the north, opening and extending far to the west. This valley we judged to be that of the Wahkarrussi, a tributary of the Kansas river. Major Emory, in his report, says: "On a branch of the Wahkarrussi, where the Oregon trail strikes it, a seam of bituminous coal crops out. This is worked by the Indians, one of whom we met driving an ox-cart loaded with coal, to Westport." In the early morning the prairie was quite level, but later became finely rolling, and was all abundantly covered with grass. After a ride of 20½ miles we encamped at Willow

spring, where we had fine cool water, but the nearest wood was distant a mile. Mr. Ross with his family encamped about fifty yards from us, and at half-past 9 o'clock was seated with his party around his fire, with his horses picketed between his tent and mine, when, without any apparent cause, six of them pulling up their picket-pins, dashed off at a frightful speed, and in a moment were far away over the prairie, and out of sight. One of them, however, trembling with fright, fortunately ran into a neighboring camp, and was secured.

June 27.—The country continued of the same character as heretofore, with less wood and water, and we only passed a little of the latter in pools two or three times during the day, during which we were often elevated on the rolling prairies high above the surrounding country, of which, to the south and north, we had extended and beautiful views. Little timber was, however, visible. The road was fine, there having been no rain recently, and the grass luxuriant. Nine and twelve miles out we passed Rock creeks, but they were nearly dry, having no running water, and were without wood. We encamped, after travelling 24 miles, on what is known as the 110-mile creek, which is lined with an unusual amount of timber; and there is in it, at present, running water, with holes large enough for bathing, as there was also four years ago, when I passed it. Near our camp are a few Indian houses and cultivated fields.

June 28.—Eight miles from camp we crossed Dwissler's creek, a fine little branch, with steep and well wooded banks; four miles then brought us to the first Dragoon creek, quite like the last, but with low banks. One mile from the last is the second Dragoon creek, with less wood and water. At 1 o'clock we arrived at Prairie Chicken creek, where there is an abundance of wood, water and grass. Distance marched, 21 miles.

June 29.—To-day, a mile from camp, we passed a little branch in which there was water, but the line of timber on its banks was thin. Three or four miles farther on we crossed Elm creek, with fine wood and running water; and still another, called the 142-mile creek, about six or eight miles out; and after a ride of thirteen miles, we crossed Bluff creek, where there are fine and abundant water and wood. At 3 o'clock we encamped on Big Rock creek, which is well timbered. As usual, the grass to-day was everywhere luxuriant. Distance 20 miles.

June 30.—It rained heavily during the entire night, and continued to do so until 8 o'clock this morning, accompanied by heavy thunder. At 10 o'clock we left camp, and without halting at Big John spring, famous on this part of the route, and of which I have cooling and refreshing recollections, passed on seven miles to Council Grove, and encamped on Elm creek, three-fourths of a mile beyond. The roads were very slippery and the mud deep. The Neosho creek, upon which Council Grove is situated, is a fine little stream, with timber more abundant than on any stream we have seen since we left the Kansas river, of which the timber is similar, and the fields of corn are remarkably luxuriant and fine. We here came up with a large number of government officers, both civil and military, on their way to their respective posts of duty. Among them was the Hon. D. Merriwether, governor of New Mexico, in whose life occurs a singular incident connected with the political changes which have transpired between this country and Mexico. In 1819 he was, as he informed me, an Indian trader, and accompanied a war party of the Pawnees too far into New Mexico. The Pawnees were nearly all slain in fair fight; but himself and servant were made prisoners and taken to Santa Fé, where he was for some time confined a prisoner in the "palace" of the Territory to which he now goes as governor, and will soon again occupy the same palace. Judges and Indian agents for New Mexico were also of the party, and General Garland was in command of the military camp, of recruits for the 9th military department, in charge of a number of officers, and a large military train.

July 1.—To-day at the usual hour we moved on again over heavy roads from the excessive rains of the previous day or two. The country differs in nothing from that east of Council Grove, except that the soil is more firm and less miry in the gullies. Eight miles out we crossed Elm creek, (on which we had encamped last night,) its waters having subsided several feet since the previous evening, when wagons could not have crossed it; and at 2 o'clock, having ridden but

sixteen miles, the train was well encamped at Diamond spring, where we enjoyed the luxury of cool water in abundance, but the supply of fuel was limited.

July 2.—The threatening state of the weather detained us in camp this morning until 8 o'clock; but as the heavy showers in sight and the distant thunder at that hour receded, we started again over heavy roads. We passed a branch of water dotted with trees on its banks, a mile from camp, and then saw nothing more of wood or water, except the rain-water of the previous day, until we arrived at Lost spring, after riding sixteen miles. The water is quite good, but not cool like that of last night. Not a tree or a bush is here anywhere to be seen; but we encamped, our previous knowledge of the place having caused us to bring a sufficiency of fuel for cooking. The country to-day was more level than heretofore, and the roads consequently not so well drained, and, as I have already said, not so well watered and timbered; but in all things else this wide, wide world of prairie is always the same—ever green and luxuriant with grass, and dotted with flowers, gently swelling here and sinking away there in soft lines and rounded figures, which it needs not the fancy of man to shape into lovely landscapes. Snipe literally swarmed on our path, and two or three fine dogs which belonged to our party were "pointing and setting" at every turn.

July 3.—At half-past 6 o'clock our train was on the road, which had been dried, and consequently greatly improved, by the hot sun of the previous afternoon. Passing over a country destitute of timber, but from the recent rains covered with abundant pools of water, and sensibly rising as we travelled forward, we selected our camp on Cottonwood creek, seventeen miles from Lost spring, and at 12½ o'clock our animals were grazing—at least those of them that could endure the bites of the innumerable flies and mosquitoes without losing their appetites. This creek is but slightly timbered, chiefly by trees which its name indicates. The day is oppressively hot, with scarcely a breeze. The thermometer in the shade of a wagon, but not well situated, indicates 100° Fahrenheit.

July 5.—We yesterday remained in camp for the benefit of our animals, one of which, however, at the usual hour of marching, took matters into his own head, and, pulling up his picket-pin, took the road, and encamped at the next usual camping ground with a train he found there. To-day we continue to ascend even more perceptibly than on our last day's march, and only passing a few pools of water and Little Turkey creek, eighteen miles out, encamped, after a ride of twenty-two miles, on one of the Turkey creeks, of which, at times, there are three. At this camp we have no wood, and the water is miserable, stagnant, and green.

July 6.—Starting at 6 o'clock, and travelling, generally, over a very level country, we arrived in twenty-three miles at a fine camp on the Little Arkansas, where, however, we are seriously annoyed by flies and mosquitoes. We passed Big Turkey creek an hour out this morning, and during the day many stagnant pools. These pools do not usually exist during the summer, but are caused by recent rains. The road over which we are now passing would be very heavy during damp, rainy seasons, and we therefore congratulate ourselves on passing over it just after it is well dried from the recent heavy rains. All day, to the south, the sand-hills and shrubbery of the Arkansas river bottom or vicinity have been visible. On the Little Arkansas there is but little fuel, and I can see that near the road it has perceptibly diminished since I was here in 1849.

July 7.—Moving over a level country for ten miles, brought us to a bushy gully in the prairie, honored with the name of Charez *creek;* for what reason, however, no one can tell, unless it be because it *never* has water in it. It is also sometimes called Owl creek. Six miles from this we came to Little Cow creek, another bushy stream, with an occasional tree to ornament its banks. There is, at the road-crossing, no water; but turning to the left, towards a fine clump of bushes and trees, I observed General Garland's large camp, with many animals, and doubtless an abundance of water. We, however, continued our march for three miles, to Big Cow creek, which crosses the road at the bottom of a deep gully, with banks twenty feet in height—firm and

easily ascended—in a little rivulet of warm dirty water. A few bushes and fewer trees mark its course to the north and south of us. It soon unites with Little Cow creek. The grass is now thickly interspersed with plats of buffalo-grass, and the whole vegetable growth is smaller and less luxuriant than we have heretofore passed. The days are oppressively hot, and the dews very heavy every night. Prairie-dog towns of large extent begin to make their appearance, with their various inhabitants—dogs, snakes, and owls. The country passed to-day is very level, with but one or two small rises. From our last camp to the present—both off the road—the distance is 20 miles.

July 8.—We left camp at half-past 6 o'clock this morning, and were more forcibly struck with the change in the character of the soil and vegetation than on any previous day; the former being more dry and sandy, the latter smaller, finer, and very short—not the grass only, but most kinds of plants, which have a wide range of prairie on which they flourish. The sand-hills of the Arkansas come into the road about twelve miles west from Big Cow creek; but they were soon passed, and we struck the level bottom of that river, which we had observed to the south of us all the morning, marked in its course by a few scattered cotton-woods along its shores and on its islands. It is a broad stream where the road first approaches it, divided by islands into two or three channels. Its current is rapid, its waters yellow, and its bed full of quick-sands; so that it is not always easy to ford it. It varies in depth. At present its waters are unusually high, being from one to six feet in various places as it is crossed. The road travelled is generally very dry at this season of the year, but to-day water filled every hole and buffalo wallow; but the road is finely dried from the recent rains. The cotton-wood on the northern bank of the Arkansas, at our camp, has been nearly all consumed for fuel by the caravans and travellers who annually pass here. We occasionally see a few Kansas Indians, who, at this season, frequent this part of their hunting grounds to hunt the buffalo, which are usually found here in large numbers. We have as yet, however, seen but a few scattered bulls, and have no hunters ambitious enough to pursue them. Distance from Big Cow creek to the Arkansas, 18 miles; to camp, 20 miles.

July 9.—Just as we were leaving camp this morning our train took fright at a rabbit pursued by a dog, and took to the prairie in every direction, at full speed, and, however serious to us, it was an amusing sight. The teams were, however, quieted in a few moments, and brought back to the road, which, in a couple of hours, brought us to Walnut creek, where we encamped just after 8 o'clock in the morning, among a motley host of Kansas, Osage, and Sac Indians, of all ages, sexes, and conditions. Walnut creek this morning is three feet deep, and some ten yards or more in width. There are fine cool springs in the banks, which, after so much pool and stagnant water, we enjoy very greatly. General Garland's command passed our camp at 11 o'clock, all in fine health; and we also parted here with Governor Merriwether and party, in equally fine condition. Our morning's march was only seven miles. While remaining in this camp we have suffered from mosquitoes beyond anything we have ever before experienced, or of which we have ever read; and, although our sentinels were doubled in number, we had repeatedly to turn out and quiet our animals to prevent their running off to escape the agony of the bites. Fortunately, during the last evening that we remained, a fresh wind sprung up, and we experienced no further trouble from these insects. Our camp, of all points in the neighborhood, was the most free from this curse. In the middle of the day, in riding into Major Johnson's camp on the opposite bank of the creek, our horses would become frantic; and such was the case for miles around. The land is low on the creek, and subject to be overflowed, as is evident from the drift-wood scattered upon the prairies.

MAIN JOURNAL RESUMED.

July 13.—As we moved forward this morning, Captain Gunnison rode up Walnut creek with Major Johnson to see the site selected by this officer for building a military post. It is on the

ridge between Walnut and Cow creeks, raised considerably above the level flat which borders Walnut creek, extending to the Arkansas river, which overflows far above the point near the road which, it is said, was first selected for this post. The site chosen by Major Johnson, five miles from the road, has the advantage also of being nearer the proposed road from the mouth of the Republican to New Mexico; but if water can be obtained still higher up, this latter road might be made still more direct. There is on Walnut creek no timber suitable for building purposes, but an abundance for present uses for fuel. The elm, ash, and cotton-wood trees are here frequently two feet in diameter at the base, but, four or six feet above, branch off into crooked gnarly trunks. The section passed to-day is generally very level. We passed Pawnee Rock, a noted topographical feature in this part of the country, during the morning. It is to the right of the road, about two miles from the Arkansas river, and terminates a ridge from the north in a bluff escarpment of highly ferruginous sandstone, twenty feet in height, on which many names of passers-by are inscribed. Shortly after leaving Pawnee Rock we crossed Ash creek—a dry bed, lined with the usual amount of timber—and encamped on Pawnee fork, after a march of twenty-eight miles. The grasses during the day became hourly poorer until we came upon this creek, where they are more fresh. The soil is also less fertile. Its surface is composed of fine sand mixed with vegetable mould, which, by the rains, becomes soft mud, and turning up in ruts, hardens, but is easily crushed again by the wheels. The water in Pawnee fork is twenty feet in width by from one to two in depth, with a fair current. During the day we passed water only in a few pools. The timber on this creek, like that of all the streams hereabouts, is small, scattered and ugly—more of bushes than trees—looking in its tortuous lines not unlike the lining to the fences of some thriftless New England farmer, who gives a wide margin to blackberry and elder bushes, interspersing them with an occasional elm. This camp, 293 miles by the Santa Fé road and 322 miles by the Smoky Hill route from our camp near Westport, is 972 feet above that camp, giving, besides the usual inequalities of a rolling prairie country, which have been duly noted, an average grade or ascent to the mile of about three feet three inches, and three feet, respectively, for these distances. Large numbers of Kansas and Osage Indians, on their usual buffalo hunts, are encamped to the southeast two or three miles on the Arkansas river, and their large herds of horses are scattered over the plains for miles. They are filthy, dirty beings, and quite as impudent and pilfering as their wilder brethren to the west. This morning they visited the party of officers spoken of as returning from New Mexico, a few miles from our camp on Walnut creek, and helped themselves to several light articles before the men who were sleeping in the wagons could be got out to disperse them.

CHAPTER II.

From Pawnee Fork to the crossing of the Arkansas river at the mouth of the Apishpa.—July 14 *to August* 2, 1853.

Forks of the Santa Fé road.—Coon creek: bad water.—Indian hunting grounds.—Dryness of the country.—Bois de vache.—Wolf in pursuit of a rabbit.—Return to the Arkansas river.—Comanche Indians.—Fort Atkinson.—Dryness of the Arkansas river at times.—Kioway camp.—Indian war party against the Pawnees.—Shaved-Head, a Comanche chief: his leave-taking.—Captives among Indians.—Ascent from Pawnee Fork.—Grass of the country.—Bluffs and rolling prairie.—Islands in the river.—Cimmaron route ford.—Line of proposed road from Fort Riley to this ford.—Sandy road.—Plains of the river bottom.—Scarcity of fuel.—Dull monotony of the Arkansas.—Winds.—Altitude above Fort Atkinson and distance from it: altitude above the Gulf of Mexico.—Unsuccessful sportsmen.—Prairie dogs in great numbers.—Incrustations of salt.—Iron ore.—Big Timber.—Bent's trading station.—Sandstone bluffs.—Scarcity of grass—Purgatory creek.—Bent's Fort.—Game.—Fords.—Advantageous position for a military post.—Timpas creek.—Railroad route indicated.—Smoky atmosphere.—View of the Spanish peaks.—Artemisia.—Game.—Crossing the Arkansas at the mouth of the Apishpa.—The river easily bridged.—Hills and bluffs.—Grades for thirty-four miles.—View of the mountains and peaks.

July 14.—Five miles from camp the road forks, (we are still upon the Santa Fé road,) and one branch follows nearly the windings of the Arkansas, to secure grass and water, while the other appears to push off for a "short cut" and "dry route" to Fort Atkinson, near which they again unite on the Arkansas river; but this appearance is deceptive; for after going a few miles it abruptly turns southward, and follows but a few miles from, and parallel with, the other road, keeping it generally in sight, as it does also the trees and sand-hills upon the banks of the Arkansas river, and is, except in the rainy season, without good grass and badly watered. We followed the cut-off route, and having made 21 miles, searching diligently for the last five or six for water, yielded to our fortunes, and encamped on the headwaters of Coon creek, on buffalo-grass and buffalo-wallow water, where we are surrounded by immense herds of these animals, which afford us a happy relief from our salt meat diet. We passed the Sacs, Osages, and Kansas Indians, on the extreme verge of their territory at Pawnee fork; and here intervenes a tract of undefined dimensions, the Neutral or Hunting Ground, which separates them from their Comanche and Kioway neighbors. The buffalo are this season more than usually crowded on this tract, which causes the Indians to extend their camps to their extreme border creeks—an unmistakable evidence that the buffalo, hunted by all, is rapidly disappearing. The country rises gently on this route for ten miles, and then gradually descends to our present camp. The short, dry buffalo-grass alone grows over the whole surface of the country, with here and there a few scattered weeds and flowers; but nature has here lost all her freshness and sweetness, and at this season only wears a gray, sterile, and forbidding aspect. On this route we see no wood, which, for fuel, is supplied, in dry weather, by the bois de vache, which was in 1849 an article of important local traffic among the Zuñi Indians, in the western part of New Mexico, as I passed through their pueblo. A thunder-storm swept over us, and heavy showers of rain during the night prevented the use of the transit theodolite, which we had set up in the evening.

July 15.—A fine badger was killed near camp this morning, but it was too much injured for preservation. Soon after leaving camp we were enlivened by the sight of a wolf in hot pursuit of a rabbit. It was an animating sight, which quite aroused the sympathy of the party, as the intended victim, panting with exertion, and straining every nerve for life, pursued by his rapacious enemy, snapping at him at almost every jump, crossed and re-crossed the road a few yards in front of us; but by his skilful angular turns he avoided these deadly bites until he had nearly

arrived at his burrow; but here the pursuer had posted an accomplice, and the rabbit was forced to make another long turn, which he accomplished successfully, darting into his burrow heartily cheered by the party, while his pursuers resumed their characteristic look of meanness, sneaking away to their covers. The day has been very sultry and cloudy, the scorching sun-rays, however, occasionally pouring down upon us oppressively. The country over which we rode is undulating, the arid buffalo fields wearing the same uninteresting aspect as yesterday, unrelieved by a single tree, except on the distant banks of the Arkansas; and the water collected in pools is barely drinkable, either on the road or at our camp. Day's march, 18 miles.

July 16.—A ride of 18 miles, over a country in all respects like that of yesterday, brought us to the Arkansas river, where we found two hundred and eighty lodges of Comanches encamped, their horses and mules in large droves grazing far and wide over the river bottom. Hosts of men, women, and children immediately surrounded us, as we passed their female sentinels, upon the bluff near the river. Some of their chief men accompanied us to camp, out of courtesy and *respect* to the party and government, liberal presents being expected in return. Camp was pitched a mile west of Fort Atkinson, where we found an abundance of grass, but were indebted to Major Chilton, 1st Dragoons, commanding at the fort, for a supply of fuel for cooking our bacon and coffee, the river bank here being even destitute of drift-wood for many miles above and below. The river is unusually high, being from one hundred and fifty to two hundred yards wide; and the Indians, in crossing it, are occasionally seen swimming; while two years ago, at this season, I am told by officers of the army and others who were then here, that it was necessary to dig in the bed of the river for water to drink. This sinking of the stream during low stages of water is not peculiar to the Arkansas, as is well known, and it is believed that water can be found always in abundance by digging in the bed of this stream. Opposite to our camp, on the southern bank of the river, the old men and the women and children of the Kioways are encamped, their warriors having joined the Cheyennes, the Arrapahoes, and the Jicarilla Apaches, with a few Comanches and others, in a war party, which it is boasted is to "wipe out the Pawnees." The Comanches are anxiously awaiting the arrival of Major Fitzpatrick, Indian agent, from whom they expect large presents, after having made a treaty. Our camp is constantly thronged with them, and though anxious to purchase horses, we have entirely failed in persuading them to sell us even a half-dozen. Shaved Head, with some of his principal men, paid us a visit just as Captain Gunnison and myself were dining. Blankets were spread for them in front of the Captain's tent, and they did ample justice to the fare spread before them—carrying off, as usual, what they could not eat at the time. After the usual amount of talk, smoking and ceremony, they took their leave, which, with Shaved Head—the principal chief of the Comanches of the Plains—is a peculiar ceremony which he extends to all whom he esteems or deems of importance. He assumes an air of gravity and solemnity of features I have never seen equalled by more civilized performers, and taking you by the right hand, gives three shakes as slow and deliberate as the time to a funeral dirge, pressing your hand with a firm grasp, and looking steadily in your eye; releasing your hand, he passess his arm through yours to the elbow, and thus facing in opposite directions he presses your arm firmly to his side; then the left arms perform the same measured functions; and during the whole of this leave-taking he repeats, "bueno," "mucho bueno," with a grave accent. Among those who came to camp we observed two or three Mexicans and others, who at some early period of their lives have been captured and are now slaves of these bands. Among them were a brother and sister, of perhaps ten years of age, but I think much younger. These children are said to have been left destitute upon the Plains by the death of their parents, and to have been several years with these bands, who found them in their destitute condition and have since provided for their wants. However much our sympathy must be diminished by the knowledge that these children have not, from early childhood, perhaps, known the mild, gentle, and improving kindness and instruction of civilized parents and society, and that now they are little ess savage than their masters, it is not the less humiliating to see that the arm which this en-

lightened and powerful nation extends to redress such wrongs, and to protect its exposed citizens, is impotent. From Pawnee fork to this camp, 68 miles by our path, the ascent is 418 feet, or about six feet and two inches to the mile. By following the river the distance would be increased slightly, and the grade thereby diminished; or by taking a more direct line the distance would be lessened, slightly increasing the grade. Our camp is under a bluff of sedimentary pebbles, deposited in layers of a few inches in thickness, interspersed with a coarse sand, and the whole cemented into a single mass. A short distance above the fort a coarse limestone crops out. The short and fine, but rich and nutritious buffalo-grass covers the hills, while tall and rank grasses spread over the bottom on the river.

July 19.—After remaining two days in camp to recruit our animals, make repairs, and procure necessary supplies, we this morning took leave of our hospitable friends at the fort, and very reluctantly parted with two young gentlemen from St. Louis, Messrs. Collier and O'Fallon, who have accompanied us for several weeks on the Plains for the recreation and the sports of the chase. Four and a half miles above camp we ascended the bluff, and passed for two miles over a ridge, which extends to the river at a single point, where a road can easily be cut in the aggregated pebbly deposit, by which the distance would be shortened, and the ascent of a hill of half a mile in length be avoided. These ridges which approach the river are of a whitish sand and clay, overlying the coarse friable sandstone of the bluffs. These bluffs are generally from one hundred yards to half a mile back from the river, rising from ten to forty or fifty feet above it, and extending back in a high, dry, and uninteresting prairie, covered with a thick mat of buffalo-grass, too fine and short for grazing draught animals, but excellent grazing for sheep and buffalo. On the river bottom heavy grasses of the blue-joint and wheat kinds grow luxuriantly, mingled with various weeds and herbs. The stream is filled with low islands covered with grass and rushes, and nearly submerged. Seventeen miles from the fort there is a ford, sometimes used by trains and parties going to and from New Mexico by the Cimmaron route; but the principal ford for that route is eight miles above this, and to reach it the road leaves the river bottom, passing over the high bluff or prairie land. We encamped about two miles above this ford on a fine field of bottom grass, which our horses eat with avidity. Had it not been necessary for us to procure supplies at Fort Atkinson, we could have arrived at this point by a shorter route than the one followed, if the appearance of the country and our recent Delaware guides, who have been frequently over it, may be relied upon, by following on and in the vicinity of Walnut creek and Pawnee fork, which rise to the north of our present camp, the latter at a distance of not more than five or seven miles. If this route is practicable—and there seems to be no reason to doubt it—the proposed road from the fort at the mouth of the Republican fork should follow it. But as a large portion, if not the whole of this route, was understood to have been examined by officers of the Topographical Corps, and already reported upon, Captain Gunnison did not deem it advisable to delay the mountain exploration to examine it.

July 20.—This was a cool morning, the clouds, which last night prevented astronomical observations, still lowering above the hills. The road was heavy for fourteen miles with loose coarse sand, and we crossed a few beds which were deep, but of small extent. Beyond this, our road became firm for five miles to our camp.

July 21.—The bottom here, as it is generally called, or land on the borders of the river below the bluffs, has two distinctly-defined plains. The lower is subject to overflow, but is at present about eighteen inches above the water, which has, however, receded from it within the last two or three weeks. The second plain is dry, and about three feet above the first at the edge, rising slightly back to the low sloping hills. On this the artemisia is now the characteristic plant, but we also observed two or three varieties of the helianthus, thistle, and geranium. Eleven miles from camp the river has cut away for a mile nearly the whole second bottom, back to the rolling plain, which on this part of the river is but slightly elevated, rising gently back from the bottom. On its southern bank the country is more than usually sandy. Returning

again to the bottom land, we encamped on the soft damp soil, after a march of twenty-two miles. Our men are obliged to cross to the islands and opposite bank of the river for fuel. With our tents pitched a few feet from the river, we enjoy the luxury of bathing. The river bed is very uneven, the whole of which is a shifting sand. Nothing can exceed the dull monotony of a journey along the Arkansas. Neither in the character of the country nor in any department of science, do we find a variety in a day's march of twenty miles. A gradual change is going on, however, of which we feel sensible; the vegetation of the rolling prairie being already parched and dry, and the earth of the hills is so compact and hard that it rings under our horses' feet, and it is often impossible to drive a tent-pin of wood into it. To-day, for the first time, we have felt the southeast wind, which travellers on this route have so often noticed in summer, and the remembrance of which is still agreeable to me; and to-day it is intermixed with hot, enervating gusts, which remind us of descriptions given of the winds of arid deserts.

July 22.—The wind blew a gale during the night, and, flying clouds partially obscuring the sun, a fresh breeze made the morning march pleasant; but before noon the wind subsided, and the day became oppressively hot. We travelled all day on a fine road, crossing several dry beds of creeks, along which, here and there, might be seen a few scattered trees. We encamped, after a march of twenty-two miles, near the river, on a dry creek, where we found a few trees, and evidences of large Indian encampments of a very recent date. This point, eighty-nine miles from our camp near Fort Atkinson, is four hundred and seventy-two feet above it—an average ascent of five feet three inches to the mile. Altitude above the Gulf, 2,852 feet.

July 23.—Our journey to-day of twenty-four miles has been on a barren plain, at the foot of the main plateau; and, although commenced with a cool, cloudy morning, was the most oppressive from heat we have yet experienced, which was greatly increased by the reflected rays of the sun from the smooth, clayey surface, almost bare; and for much of the distance quite destitute of vegetation, except a few scattered weeds and sun-flowers. Near our present camp we passed two dry creeks, on which there are a few scattered clumps of cotton-wood, with a few trees of large diameter, but crooked and short, with large, unsound branches. On the river banks, also, there is more than the usual amount of this timber, while the sand-hills on the southern bank come close in to the stream, and, like the rolling prairie hills to the north, increase in height.

July 24.—Captain Gunnison made an unsuccessful effort to procure specimens of prairie dogs for preservation, by pouring water into their holes, in a village near camp; nor was he more successful in digging for them, as they easily eluded his search, (although he had a large number of men at work,) in their burrows, which are formed of numerous passages, which they extend rapidly when pursued beneath the surface of the ground. The amateur hunters of the camp were equally unsuccessful, and after scouring the neighborhood for game, returned to their coffee, bacon and bread, only with good appetites.

July 25.—Yesterday we were oppressed with heat, and to-day, with the same clothing, should shiver with the cold. Prairie dogs, which are the most abundant live creatures along the road, are, to-day, torpid. The road followed the base of the hills from our last camp, at a distance of from one to three miles from the river. At fifteen miles from camp we found salt effloresing on the surface of the ground, and salicornia growing abundantly on the bottom. At the base of the hills, which are here gentle and sloping, "in the tertiary drift, are cylinders and rounded nodules of iron ore, similar to those larger ones found on the Chugwater, at the base of the Black Hills." Day's travel, 21 miles.

July 26.—The night was cool, with a slight fall of rain at daylight; and, although the thermometer in the early morning stood at 59° Fahrenheit, it was so material a change from 96° in thirty-six hours, as to be uncomfortable. Seven miles from camp we reached what is called the Big Timber, a section of the river of about twenty-four miles in length, on the islands and banks of which more than the usual amount of cotton-wood grows. It deserved the name, however,

only when compared with this river as I have described it a few days back. The trees are scattered over the bottom, in numbers, not unlike those of the new cotton-fields of Georgia and Alabama, with inviting shades; but they are not thick enough to obstruct the view, and the opposite bank of the river discovers the same dry hills as heretofore. Three miles of heavy sand, and six in the rain, over very slippery clay, added greatly to the labor of the day's travel, and we encamped at the end of twenty miles. In the afternoon the sun came out, but as yet we have had no glimpse of the mountains. Altitudes of Jupiter and Antares were obtained here for latitude; but the early hour of the day, and misty state of the atmosphere, prevented taking occultations or eclipses of Jupiter's satellites.

July 27.—A dense fog hanging over the valley until 10 o'clock, concealed the sterile hills of the opposite side of the river, and, leaving in view only the line of timber as we rode near it, awakened remembrances of the beautiful forests which sometimes skirt the western prairies. A mile from camp we passed two or three log-houses, occupied as a trading station by Mr. Wm. Bent, during the past winter, but now left vacant, and, as yet, undestroyed by the Indians. Here the bluff lands for a short distance come quite in to the river, and disclose sandstone in horizontal strata, of a reddish, argillaceous character, which we observed during the remainder of the day on both banks of the river. Thirteen miles brought us to the termination of the Big Timber, where the argillaceous sandstone hills again approach the river, and the road passes quite frequently over these small spurs. The bottom of the river at times quite disappeared, and was lightly covered with grass, or destitute of it entirely, after leaving the timber. Our camp is on a very coarse grass, under a sandstone escarpment, in a large meadow bottom—by far the poorest camp we have yet made. Mr. Creutzfeldt found to-day the skin of a snake seven feet in length, which it had cast, leaving the eye and every scale perfect.

July 28.—Three miles from camp we passed opposite to the mouth of Purgatory creek, an affluent to the Arkansas, and timber appeared more abundant upon it than upon the river, which it enters in quite a large bottom, which, from a distance, is apparently well wooded, and grass is abundant. We encamped, after a march of fifteen miles, three miles below Bent's Fort. Latitude by meridian observation to-day, 38° 03′ 27″. Mr. Homans, who has been suffering seriously from being poisoned with ivy, has very nearly recovered. He was too ill for many days to mount his horse, and could only ride in a carriage with the greatest difficulty. Deer, antelope and turkeys were seen along the river to-day, and near camp a cow was found which had been abandoned by its owners, her feet being too sore to travel. Our elevation at this camp is 3,671 feet above the Gulf, and our average ascent for the last 105 miles, from our camp of the 22d, has been 7¾ feet to the mile.

July 29.—Between camp and Bent's Fort, grass was very abundant. We spent an hour in examining the river at the fort for a practicable ford, but the excellent one which formerly existed here it was found impracticable to cross, in the present stage of the water. Mr. Bent abandoned his fort about four years ago, but not until he had destroyed it. Its adobe walls still stand in part only, with here and there a tower and chimney. Here, beyond all question, would be one of the most favorable points for a military post which is anywhere presented on the Plains. There is an abundance of pasturage, fuel, and building material in the neighborhood, for the use and building of the post. It is of easy access from its central position, from the east, from Santa Fé, from Taos through the Sangre de Cristo Pass, and from Fort Laramie. It is on an emigrant road from southern Missouri and Arkansas, either by the North Park or Coochetopa Pass; and it is in the heart of the Indian country, accessible to the resorts of the Comanches, Cheyennes, Arapahoes, Kioways, some bands of Apaches, and even occasionally of the Utahs of New Mexico.

We moved on at half past 8 o'clock and encamped, having marched twenty-four miles, on miserable grass—not being able, after hours of searching, to find better. Indeed, during the day, after leaving the fort, we saw no good grass for this country even, on either bank of the

river. A few miles above the fort we passed the mouth of Timpas creek, marked on the southern bank by a break in the hills and a tree or two only. It is small and often dry, or nearly so. Most of the day the road led over the higher land, which is here considerably broken. "Still it is easy to grade a railroad along the edge of the bottom." "On the southern side of the river a broader flat is seen, which, in the event of a railroad being made here, should be its site, crossing the river a few miles above Bent's Fort, and passing over the angle between the Huerfano and the Arkansas rivers." The atmosphere for many days has been so cloudy that we have seldom had a distant view; and for the last two or three, smoke has quite obscured the whole country, so that we could see but a very few miles. A small opening in the clouds and smoke, however, an hour ago, gave us a first but not very distinct view of the Spanish peaks, bearing nearly southwest; but it was only a momentary view, and we were again left to gaze on barrenness and a circumscribed horizon. The bluffs above the fort, for several miles, are underlaid by nearly horizontal strata of a whitish, argillaceous, friable sandstone, which crumbles easily; the whole base of the hill being covered upwards for several feet with fallen fragments. Our camp is in the midst of fields of artemisia of several varieties, the principal of which are known as sage and greasewood; and, to add to our discomfort, it began to rain at sundown, softening the clay and rendering it so slippery as to make walking very uncomfortable.

July 30.—To give time for the rain of last night to dry up to some extent, our departure was delayed an hour, which Captain Gunnison and myself, with a number of men, spent in search of a ford, but without any favorable result, the depth of water and rapidity of the current being too great, although the bed of the river was firm, being of water-worn stones of a small size. Our route again followed the high prairie for seven miles, and then descended to the river bottom, where we soon came to fine fields of coarse grass; but we were anxious to reach the Huerfano, that astronomical observations might be taken while we found the means of recruiting our animals and of crossing the Arkansas. According to the maps we had with us, and in the opinion of several men of the party who had passed here before, the Huerfano was believed to be already in sight, and, after ascending two or three high hills in the vicinity and obtaining a distant view of a broken line of trees in the direction in which this stream was believed to be, we turned in towards the river and encamped after travelling only eleven miles. A few deer were frightened from the coarse, rank grass as we entered it near the river, but, as usual, they escaped our marksmen. Captain Gunnison, whom I accompanied, went in search of the mouth of the river, which we found in a bend of the Arkansas immediately south of the camp, and of a ford by which to cross the latter stream: in this, however, we were unsuccessful, and it was not until the following day that Captain Gunnison found one, on the northern bend of the river, half a mile west of our camp. The river at this point was 300 yards wide, varying in depth from one to three feet, with a strong current and sandy bed. The 31st of July was passed in camp, and on the following morning the banks of the river were cut down, and Captain Morris' wagons, with large wheels and broad tires, crossed successfully. The remainder of the wagons were not so favorably constructed for crossing fords, and Captain Gunnison, deeming it unsafe to attempt to cross them with their loads, built a raft of logs at a point on the river where it was fifty yards in width, a short distance above the ford. It was only by the greatest labor and difficulty that a rope could be carried across the stream, the current of which was very rapid at this point, but was accomplished, after one or two failures, by ascending the stream some distance and stationing men at short intervals along the rope, who entered the water in succession; the leading man pushing rapidly for the opposite shore, which he was barely able to reach, securing the rope by the aid of a man stationed there to assist him. One of the men—the second—in his desire and determination to succeed in crossing successfully, had lashed the rope with his handkerchief to his arm, from which he narrowly escaped a serious accident as his companions dropped the rope, the current sweeping him under with such force as to deprive him of all power in his bound arm; but he was rescued by the leading man returning to his

assistance. The raft once in successful operation, lightened the wagons of half their loads or more, which were safely landed on the opposite bank at sundown, and the wagons thus laden were crossed at the ford before the twilight rendered it unsafe. The Arkansas could be easily bridged at the point where this raft was operated, the banks being several feet above high water in times of freshets, and approaching unusually near each other. Opposite to our camp of July 30th, and to the east of the stream which here enters the Arkansas from the south, are three hills, two conical and one oblong, rising some 250 feet above the river, and 100 above the general level, distinguishing land-marks for the stranger. The bluffs to the northwest of that camp rise still higher above the adjacent hills. Our average ascent for the last thirty-four miles, has been twenty feet and seven inches per mile.

August 1.—We were gratified this evening by a clear and beautiful view of the Spanish peaks and of the Greenhorn mountains, with others just rising above the horizon to the north and south. From the summit of the bluffs on the north bank of the river, James' peak is distinctly seen; and upon all the high ranges the snow is visible, accounting for the high water in the streams which rise in them.

CHAPTER III.

From the mouth of the Apishpa, via the Sangre de Cristo, to Roubideau's Pass.—August 2 to 25, 1853.

Valley of the Apishpa.—Rocks and soil of the hills and valley.—Small cañon.—Examination of the cañon.—Indian writings.—Cacti.—Small pines.—Route of the wagon train.—Rocks and grass.—Game.—Appearance of the mountains.—Fossils.—Flowers.—Wild horses.—Timber on the Arkansas in sight.—Rains, dews, winds.—Course of the Apishpa, and broken character of the country.—Discovered that we were not on the Huerfano.—Road to Raton Pass.—Cuchara river.—Fine view.—Trip to the Greenhorn settlement.—Clay and shale banks of the Cuchara.—Dog towns.—Wild horses.—Huerfano river and butte.—Huerfano cañon.—Apache creek.—Trail from Taos.—Trader's camp.—Granaros.—Greenhorn settlement: its population and productions.—Massalino, the guide.—Sleeping apartments in Greenhorn.—Huerfano butte.—Direct line from the Arkansas to the upper Huerfano, leaving the former above the mouth of the Apishpa: its railroad character.—Size of the Huerfano river.—Soil.—Building-stone.—Ascent of the Huerfano.—Taos trail, via El Sangre de Cristo Pass.—Approach to the Sangre de Cristo Pass.—Sand and limestone.—Railroad route.—Timber.—Flowers.—Game.—Difficulties in the approach.—The passage of the Sangre de Cristo Pass.—Scenery.—Game.—Distances, altitudes, grades.—Railroad line through the pass and its western descent to Fort Massachusetts.—Examination of the mountains to the south of the Spanish peaks.—Hunters from Taos.—Snow in and about the Sangre de Cristo Pass.—Trip to Taos.—San Luis valley: its streams and settlements.—Indian signals and robbery.—Red river of the Rio Grande del Norte.—Valley of Taos: its settlements and cultivation.—Return to Fort Massachusetts.—Antoine Leroux, guide.—Men discharged.—Mr. Taplin.—White Mountain spring.—Sage in San Luis valley.—Roubideau's Pass: its rocks, character, grades, elevation.—San Luis valley, and mountain chains enclosing it.

August 2.—Our route, following the creek, lay up a plain valley for five miles, ascending more rapidly than that of the Arkansas; then for $8\frac{1}{2}$ miles about the same, with a far wider and better grassed plain than on that river. There are no bottom lands on this stream, which flows in a deep, narrow passage, with precipitous banks, cut in the argillaceous soil of the plain. Such water channels, with steep earthy banks, are styled arroyos by the New Mexicans, in contradistinction to cañones, which are walled with rocks. At a few yards distance in the plain, one would not here expect to find water, even though acquainted with the character of the country, much less a cool mountain stream. The banks, twenty feet in depth, are green with grass, the arroyo at top being twenty-five or thirty feet in width; but we only found one point during the day's march at which we could descend to the water, which is at a point where the plain is underlaid by a stratum of shale. This creek, in this part of its course, hugs the base of a line of hills sloping down from the east; the valley at our camp being about a mile in width, sweeping up gently to the west and southwest for several miles, where it appears terminated by elevated hills. Thermometer in the shade during the warmest part of the day, 104° Fahrenheit.

August 3.—The survey was continued along the valley of the creek, rising gradually for $2\frac{1}{2}$ miles over a gentle swell, extending in towards the stream, to a nearly level prairie, from two to three miles in width, extending for nine miles in a course S. 23° W. We encamped at the mouth of a small cañon on the creek at the foot of the hills terminating this plain. The party being without a guide, it was found necessary very often to make distant excursions to the summits of the most elevated bluffs and hills, from which extensive views could be obtained, and the courses of the streams and main depressions of the country followed by the eye. These bluffs and hills passed to-day, as also the banks of dry ravines and creeks, were sometimes composed of a red sandstone and of strata of shale, and at others of a sandstone of a yellowish shade, from the disintegrations of which the soil of the hills and valley is formed, being light and friable, in which the felloes of the wagon wheels sink deep and cast up clouds of dust, from the pungency of which we judged the cement of the sandstone to be carbonate of lime.

August 4.—Captain Gunnison, with a small escort, proceeded to examine the cañon this morning. He found the water at its mouth running over a sandstone ledge for 500 feet, with falls of 1½ feet, occurring at pretty regular distances of about 100 feet. "This," he remarks, "is the first sound which has given me notice of a water-fall since leaving the mountains in New York." Above this he entered a gorge, in which the current is sluggish, running in a deep gully, which he followed for a mile, coming to a high perpendicular escarpment of rocks on the right, on which are numerous hieroglyphics or Indian writings, "which appear to have been made at various times, but are mostly of a recent date." A mile and a half from this inscribed rock, large masses of fallen rocks blocked up the way, or bench, six feet in width on one side of the creek, the bed of which is fifty feet below with nearly perpendicular banks; the passage on the opposite side was even worse than this a few yards above, the creek washing under the bluff, preventing the passage of horse or footman. The rocks are soft sandstone, easily cut. He then ascended to the second table, or inclined bench, which he found covered with broken fragments of prismatic stones with sharp edges; the crevices and open parts of the rocks were filled with gigantic cacti, some of which were five feet in height, with lobes in whorls around the main stem, the branches themselves standing off like radii from the centre of a circle. They had flowered and, the corolla having fallen, had left the top like a small cup. Ascending eighty feet above this table, "we came to some pines of a stunted growth, but a few of them a foot in diameter. They are of the three-leaved or pitch-pine species of the east. Dwarf cedar also grows in these rocky precipices." "Near this point a cañon comes in from the south, extending several miles to some high lands. Above this the cañon of the main creek widens, and could be followed by wagons, but would require working at various points. In following along the cañon, or near it, several rocky gullies were passed, and were followed by cañones perpendicular in their course to that of the creek, with sides nearly one hundred feet in height. The main course of one of them was slightly north of west, towards the Greenhorn mountains, for six miles; then diminishing in size, spread out into several smaller ones." Following this cañon, Captain Gunnison came upon the trail of the wagons, and soon after arrived at camp. In the mean time the remainder of the party, with the wagon train, finding it impossible to follow the course of the creek, in consequence of the side cañones and deep chasms, with abrupt and often vertical walls, of fifty and a hundred feet in height, had followed up one of them by a long up-hill march, turning ravines, first in one direction and then in another, until we at length came to a practicable pass over the first cañon, where we resumed our course for the creek, but were almost immediately intercepted by another no less formidable cañon, up which we followed until we were fortunate enough to find water remaining in pools from a recent shower, and also a not difficult crossing to the cañon. We encamped here, having travelled but fifteen miles; but as we were without a guide, and had not been able to get water for our animals during the march, it was necessary to halt, not knowing where we should again meet with it. We have all day passed limited but luxuriant fields of grass in the cañones; grass is also finely scattered over the hills. The rocks of the hills and cañones are red sandstone. We have been forced, in searching for a passage, nearly to the summit of the divide between the waters of the creek at our morning camp, and of the Arkansas river; and it is becoming more than doubtful if we are not following some other than the Huerfano river. I rode forward several miles before dismounting to ascertain something of the nature of the country, and the proper direction for the following march, and returned to camp through large herds of antelope.

August 5.—We pursued our course to-day, from the observations made after our arrival in camp yesterday, without difficulty. Passing the head of several dry cañones, and branches of them to the south, we descended, about three miles from camp, into a broad valley, in which are standing two yellow sandstone buttes on a base of soft shale, some hundred feet in height above the surrounding country. I ascended one of these with considerable difficulty to its narrow summit, and obtained an extensive view of the adjacent country. From one side of this butte

the water descends in a broad valley to the south, and from the others it runs off to the west and north, to branches of the Arkansas; and we were evidently on the divide between these streams where their side valleys meet, and their lateral and perpendicular cañones necessarily terminate. In every direction were bluffs and knobs, and ledges of rocks whose sides and tops were covered with the short, crooked, wide-spreading cedar of the country, with here and there a stunted pine. Grass was everywhere abundant, and game in every hollow and valley, and, save the light, argillaceous soil and want of water, our course was evidently easy for the day. The mountains before us looked grand and formidable, our proximity and elevation for the first time giving us a fair and full view of them from their summits, streaked with drifts of snow, to their base. The summit of this butte, however, so swarmed with winged ants that I was driven from it in haste, literally covered with them, and it seemed their especial delight to get into my eyes, either on foot or by the wing. A few fossils were hastily gathered from it. A few yards from its base a fine field of flowers tempted my curiosity, and searching for the finest cluster, I rode to it, and stooped from my horse to gather it, when the warning rattle of a large snake coiled under it caused me to withdraw my hand from danger in time, and, selecting other flowers, I left him undisturbed in his flowery retreat. A few wild horses coursed around us, and excited the spirits of our horsemen, but it was not deemed prudent to break down good horses in their pursuit for the chances of capturing wild ones, and they were left unmolested to pursue their course, and enjoy their natural freedom. The timber on the Arkansas was visible during some part of the morning march, and it was evident that the route we had pursued was not the proper one for a road after crossing that river, as this point can be easily reached, if necessary, by a nearly direct course from that crossing. In our search for water, Captain Morris and myself ascended a small butte, and discovered pools with large herds of antelope and a few deer feeding near them, a short distance to the west; and through an opening in the hills, a few miles to the W. N. W., were seen the green leaves of the cotton-wood. Leaving the party to encamp at the pools, we proceeded at once to the cotton-woods, and found, as we anticipated, a fine stream, larger than that we had been attempting to explore; and it was at once evident, from the position and course of this, and the great southern bend of the former that it could not be the Huerfano. During this ride we were drenched with a heavy shower, the third which we, who travelled by the Santa Fé road to Walnut creek, have actually encountered on this long journey, although we have been every day in sight of them, and often surrounded by thunder-showers within a stone's throw. The dews, which are said generally to be uncommon west of Walnut creek, have been as heavy and constant with us this year, west as east of that creek. This, I think it not improbable, may be accounted for by the almost entire absence this season, on this route, of the prevalent southeasterly winds of the day, which are changed to westerly winds at night; for we have seldom enjoyed a pleasant breeze at any time on this march to this point; and I remarked in crossing from Fort Leavenworth to Santa Fé in 1849, that the dews were regulated almost entirely by the prevalence or absence of winds at night. Since leaving the Arkansas river we have seen nothing of flies and mosquitoes, which were there a severe daily and nightly torment to men and animals. Captain Gunnison, with a small party, left camp early in the morning to continue the exploration of the cañon of the main creek; but after riding in a nearly southern course over a country intersected by cañones, ravines and rocky cliffs, rejoined us at a late hour in the evening, not having succeeded in reaching the Apishpa, which we afterwards learned was the name of the stream we had been following. It rises to the south of the Spanish Peaks, and is not unfrequently dry; indeed no water entered the Arkansas from it a few days after we passed it.

August 6.—After travelling two miles in the direction of the Spanish Peaks, we were obliged to cut timber and fill up a small branch over which we crossed, and bearing thence more to the west, struck a wagon trail leading from the Raton Pass to the Pueblo on the Arkansas river, and Fort Laramie on the Platte. This we followed to the Cuchara, which is forty feet wide and two

deep at the ford which we crossed. Encamping two miles above the ford, Captain Gunnison ascended a neighboring butte, and thus describes the view: "Pike's Peak to the north, the Spanish Peaks to the south, the Sierra Mojada to the west, and the plains from the Arkansas—undulating with hills along the route we have come, but sweeping up in a gentle rise where we should have come—with the valleys of the Cuchara and Huerfano, make the finest prospect it has ever fallen to my lot to have seen." Accompanied by five men, I started at an early hour of the morning in search of the Greenhorn settlement, on a stream of the same name rising in a range of mountains to the east of the Wet river valley, to obtain information of the country, and, if possible, procure a guide well acquainted with it and with the mountain passes we were about to explore. Our course from camp was W. N. W., in a direct line for the Wet mountains, crossing the Cuchara at the point at which we had visited it the previous evening. The banks were here vertical walls of clay, twenty feet in depth, resting on a stratum of shale. We descended through a break in the bank, and following the bed of the stream for some distance, ascended the opposite bank through a similar opening. The borders of the river are here entirely destitute of grass. A few miles below us, plainly in sight, the river enters a cañon; the hills about it, and an unusual extent of rolling country, being covered with a thick growth of low cedar. On the table-land beyond this river we passed innumerable prairie-dog towns, herds of deer and antelope, and several bands of beautiful wild horses, which came circling round us in all the pride of their native freedom, at a distance of fifty or eighty yards, and at the report of a rifle dashing wildly away over prairie, hill, and valley, exciting our admiration. On this table-land we also passed basins of rain-water some hundreds of yards in diameter, which in dry seasons are themselves doubtless dry. Ten miles from the Cuchara we descended from the table-land to the valley of a stream evidently rising in the position laid down on some maps for the Huerfano, and on whose southern bank we had an hour before had a fine view of an isolated butte in its bottom—a feature of this valley marked and unmistakable. It is from this butte, from its isolation known as the Huerfano or Orphan butte, that this river derives its name. This stream we crossed as we had the Cuchara; its volume of water being less than that of the latter stream, and its clay banks, overlying the shale of the bed, of less height. The Huerfano between this point and the head of its cañon, seen a few miles distant to the east, and which is said to be the longest in this part of the country, has but little timber on its banks. The Cuchara enters the Huerfano in this long cañon, and the river for eighteen miles between the mouth of its cañon and the Arkansas, it is said, has a large border of cotton-wood. We next came to the Apache creek, whose sources in the Wet mountains had been visible during our morning ride. It is a small mountain stream, with water at this time only in pools. Willow, plum, thorn, and cherry bushes, with a few cotton-wood trees, grow densely thick on its borders, and we were detained an hour in making a passage through them. Beyond this creek we entered upon a wide open valley of weeds, prickly-pears, and sand, and I changed my course a little more to the north, hoping to strike the trail from Taos to the Greenhorn near the base of the mountains, which we reached after a ride of four miles, finding the trail as anticipated. Following this trail we rose over a hill and descended into a rough narrow ravine, which we followed in a northeast direction for a mile and a half, and then passed over a high ridge—a spur of the Wet mountains—covered with oak bushes, to another ravine, on the sides of which we were gladdened by the sight of a herd of cattle and horses feeding, and were soon in the camp of a trader from New Mexico returning from Fort Laramie. From him we learned that the two streams and ravines are called the Granaros, by the Spaniards. Passing over another sharp ridge, we descended in two miles to the fine little valley of the Greenhorn, a stream of two feet in width and three or four inches in depth, which is now entirely diverted from its natural channel and employed in irrigating the lands of the six New Mexican families who reside at and constitute the present population of the place. They plant a few acres of corn and of wheat, of beans and of water-melons—in all, an area equal to that of the farm of a small eastern farmer, who cultivates his own fields. Two hun-

J.M. Stanley, from a sketch by R.H. Kern.

Lith by A. Hoen & Co Balt.

WA-HA-TA-GAS OR SPANISH PEAKS

From near the Cuchara Aug 6th

dred fanegas of wheat and fifty of corn, with the requisite amount of beans and melons, constitute the largest total crop of this valley. They have a few cattle and horses—the latter very poor. The houses are built of adobe or sun-dried brick, without windows or other openings than a single door, in entering which a man of six feet in stature must bow very low. In front of each house is enclosed a small space of ground, twenty yards in width, by poles planted in the earth and lashed to horizontal strips by rawhide thongs. These picketed yards are intended as a protection against Indians—the Utahs having killed some of their cattle last year, destroyed their grain, and stolen their horses. Corrals are attached to the backs of their houses, built in all respects like the front enclosures. With one exception all the houses of this settlement are joined, and a tall man can reach to the roof, on which the whole population, not absent in the fields, assembled on the approach of my party, not knowing whether to expect friends or foes. I enjoyed the hospitality of the smaller mansion, being invited to a seat on the only article of furniture in the room, a bench against the wall, spread with a blanket and furnished with a pillow. On the earthen floor, at the sides of the room, were two or three narrow beds on wool mattresses. I soon found the guide I wanted, and engaged his services hence to Fort Massachusetts, in the San Luis valley of New Mexico. Massalino is, by birth, of the Spanish New Mexican race, of about forty-five years of age; and having spent it entire in the wild life of a mountaineer—by turns a hunter, a trapper, a trader, a voyageur, a fighter, a farmer, and a guide—he is familiar with the country westward to the Pacific. Last year he lived at this place with his Pawnee squaw; but his losses by the Utahs were considerable, and he removed to the Pueblo, on the Arkansas, where he is, with his family, the sole occupant of the place. He planted a little corn there, but the high water of the river destroyed it, and he has no crop now growing. "I have lived *nine years on meat alone, at one time*," said he, "*in these mountains*, without tasting bread or salt; and I can now live well enough for me with coffee and the *little* meat I can kill." He is reputed a fine hunter. "I never see a grizzly bear but I give him a shot. I try to hit in the right spot; but if I miss it, I have to run. We will have," alluding to our trip, "a fine chance for fun;" and his dark liquid eyes flashed as he looked towards the mountains, and visions of his grizzly friends appeared to his imagination. But few men of experience are bold enough to attempt to shoot these animals unless accompanied by a friend well armed. The mistress of the house very courteously inquired where I would have my bed prepared, which I preferred leaving to her own convenience. I should, however, have been a little surprised, had this been my first visit to a New Mexican residence, at the place selected—in the yard, just in front of the door, under the broad, bright, blue canopy of heaven, brilliant with stars. I enjoyed the matronly grace and dignity of the mistress as she brought forth the pallet and spread the necessary blankets to exclude the chilly night winds from the mountains. There, too, were spread the beds for the family, the open air being preferred to the house during pleasant weather. I could, of course, procure no supplies at this place at this season of the year.

August 7.—I returned this morning by a route somewhat to the west of that followed yesterday; and after passing the Granaros, crossed the Huerfano at the butte, and soon after reached camp, which had remained on the Cuchara.

August 8.—We crossed immediately over to the Huerfano butte by the route which I had followed the previous day. This butte is one hundred and fifty feet in height, as determined by Mr. Homans, standing in the river bottom quite detached from the adjacent hills. Its diameter at the base is equal to twice its altitude, sloping up to its summit, which is about twenty-five by forty feet across. Its base is strewn around with prismatical blocks of granite rocks, of from one to six feet across, and its surface is also covered with these prisms, which are very dark—containing iron, perhaps, as a coloring matter. A narrow way, leading over the summit from the southeast, is nearly destitute of these rocks, on either side of which they are arranged in regular order, presenting a trap-like appearance. Latitude of this butte, 37° 45′ 04″. Captain Gunnison remarks in his journal, that our line of travel since leaving the Arkansas should not be followed; "but,

striking up a valley or plain ten miles from the mouth of the Apishpa, in a course for the Spanish Peaks, cross the Cuchara near our camp of August 5th, and continue over to the Huerfano, which gives a direct line of travel on a fine plain. But if we undertake to ascend the Apishpa, or the Huerfano, by following their valleys, we meet with cañones on the former, as we have described, and on the latter, as we are informed, eighteen miles above its junction with the Arkansas. And the whole country having been under our eye as we travelled on the higher land to the south of this indicated route, we can say that no obstruction of any magnitude exists, thus far, to the successful construction of a railroad."

August 9.—The river here is eighteen feet wide, by one deep, with a rapid current. The soil is light, but would produce, if irrigated, fine crops. Stone of a superior quality for bridges and building purposes may be readily had. We moved up the river for several miles on its southern bank, and then crossed to the north side, and a mile above recrossed by the ford on the Taos trail to the southern shore, but only to recross again and again, five or six times, the river here coming through a narrow passage formed by the Greenhorn mountains, or Sierra Mojada, on the north, and spurs from the Sierra Blanca on the south, of some six hundred feet in width in its narrowest part, but still good for a wagon or a rail road, with a little labor. The Taos trail of which I have spoken leaves the river at this gorge, leading directly to El Sangre de Cristo Pass. Captain Gunnison finding a better route, however, kept up the river, encamping on its northern bank, where the hills are covered by small cedars and pines. Day's march, 14.54 miles.

August 10.—We crossed the Huerfano this morning, and pursued a fine valley between two spurs from the main chain of the Sierra Blanca, luxuriant with grass, from one-half to one mile in width, to the base of the mountains five miles to the south; and then turned east by a low depression into an adjacent valley, and encamped at its head, as it began to rain, after a march of seven miles. Narrow ridges of sand and limestone of considerable height, covered with wide branching cedars, suitable only for fuel, and a few dwarfed pines, extend from the base of the mountains north to the Huerfano, along the summits of which a road could easily be constructed, diminishing the ascent to the pass. Ours was to-day literally a pathway of flowers, among which the helianthus, a verbena, a lupine, and the blue flowering flax, were brilliant and showy. Magpies flew around us, but escaped our shots uninjured. Bears were seen on the Huerfano and our hunters supplied us abundantly with venison.

August 11.—We left the valley of our camp by ascending a giant mountain spur, along the top of which we followed to the south for some distance, ascending as we approached the main mountain, and then descended into the next eastern ravine or valley, through which flows a little rill entering the Huerfano at the gorge which we passed two days ago. This descent was difficult, and so sideling that we were obliged to hold the wagons by hand-ropes to prevent their being overturned. By following the rivulet from the river this difficulty would be avoided. We ascended it for some distance through waving fields of grass quite up to our saddle-girths; and, cutting a road for a short distance through a forest of quaking-asp as we turned to our left, encamped, in a shower of rain, amidst luxuriant fields of blue grass (of the mountain men) and flowers. Quaking-asp covers the mountains around us, interspersed with small pines. Fire, however, swept over these mountains two years ago, destroying much of the timber. Sandstone, an impure limestone, and porphyritic rocks, are among the most common of this part of the mountains. Distance marched, 5.12 miles.

August 12.—A working party was engaged during yesterday afternoon in opening a road through the forest to the summit of the pass, and much of to-day has been spent in the same manner and in working on the opposite side-hill, along which it is necessary to descend from the pass. The teams, too, were engaged all day in making the ascent as the road advanced, and at dark the most of them had reached the summit, and a few had descended to El Sangre de Cristo creek; and all were obliged to encamp where night overtook them, on a line of two or three miles, on the summit and either side of the pass. The examination of the various

J. M. Stanley, from a sketch by R. H. Kern

Lith. by A. Hoen & Co. Balto.

VIEW OF SANGRE DE CRISTO PASS

Looking northeast from Camp north of Summit, Aug. 11th

depressions in the mountains also went on to-day, to ascertain their elevations and practicability for roads. The scenery around us is very fine—the views from various points extending far back over the plains, buttes, ridges, and streams, on which we have for so many days laboriously pursued our march. The bold, rocky mountain peaks tower loftily above us—whitened here and there with lines of snow—around which, at mid-day, dark masses of clouds gather and the lightning plays, while torrents of rain pour down their sides with irresistible fury. The mountain valleys are small, but unsurpassed in luxuriant grass; and the mountain sides are plentifully supplied with aspen and small pine, and all around us, and under our feet, covered with exquisitely beautiful flowers. Here, too, the geologist finds an interesting field, and sportsmen's spirits are excited by grouse and pheasants, deer and grizzly bear, in every valley and glen, and the streams are alive with the finest mountain trout.

August 13.—The labor of crossing the ridge was completed this morning, and just in advance of the 1 o'clock shower we encamped in, but near, the head of the southern descent of the pass, on the Sangre de Cristo, which is a small stream of clear, cold water, in a beautiful little park or valley. The labor of crossing this summit has been very considerable, which is partly owing, however, to the rarified atmosphere at so great an elevation. Both men and animals were soon exhausted and obliged constantly to stop and rest, where at a lower altitude no rest would have been required. Our teams were all doubled, without being then able to do the ordinary work of a single one, and the strongest men sat down out of breath after a few moments' exertion. Astronomical observations gave us for the latitude of this camp, which is 2½ miles from the summit passed by the wagons, 37° 36′ 52″ N.

From the Arkansas river, at the mouth of the Apishpa, it is eighty miles by the route we travelled to the Huerfano butte; but this distance is at least one-fourth greater than is necessary in the construction of a railroad between these points. Taking the shorter distance our ascent was 28 feet 10 inches, in whole numbers, to the mile, the elevation of the butte being 6,099 feet above the sea. We ascended the Huerfano river 14½ miles above this point, ascending nearly 52 feet 10 inches per mile. The ascent during the first day's march from the Huerfano river to the base of the Sierra Blanca, 7.59 miles, was 603 feet, or 79 feet 5 inches per mile. On the following day we advanced 5.12 miles, ascending in that distance 1,289 feet, or over 251 feet per mile; and from thence to the summit of El Sangre de Cristo Pass, seven tenths of a mile, the ascent was 647 feet, developing a line entirely impracticable for a railroad. But the Huerfano river, west of the gorge through which we passed on the 9th instant, drains a large circular amphitheatre, surrounded on the north, west, and south, and partly on the east, by elevated mountain ranges, with large, irregular spurs extending into this valley, and sending down numerous tributaries to the river. Twelve miles above this gorge stands the Black butte, an immense mass of rocks with irregular points shooting up 100 and 200 feet. Here comes in a fine stream from the northwest, two miles beyond which another enters from the west from near Williams' Pass. At this point the Huerfano, whose general course from the gorge is N. 70° W., bends towards Roubideau's Pass on a curve for some three miles, where it receives the waters of Gunnison's creek, a small stream from the south, but which towards its source descends more from the east. This little creek continues the curve, until it reaches the point whence it issues from the mountains at the foot of the declining ridge, near which, but on the opposite side, our wagons passed, at the head of a small valley on leaving the Huerfano. Following this stream above this point, it is, by chain, five and one-fourth miles to the summit, the water descending on an inclined plane without falls, with an equable, swift current. Four miles and a half from the summit the creek flows through a narrow passage in the rocks, which slope up to the top at a small angle from the vertical, the width at bottom being one hundred and fifty feet, affording abundant room for the stream and a road. Above this gorge or cañon there is a small park, such as are found on the heads of many of the streams in this part of the country, abounding in deer, elk, and bear, and affording luxuriant pasturage for thousands of head of cattle: indeed, few more inviting spots for

grazing can anywhere be found. Two miles and a half from the summit is Turret rock, a pillow-like cone of stone, divided in the centre from the apex, with one face a plane, against the base of which the stream strikes and is deflected a little to the left. Above this, numerous small streams join the main one from the southeast, and that from the summit descends at the foot of the grassy slopes which extend up to the base of the crowning peaks of the Sierra Blanca. A railroad or any judiciously chosen wagon road would cross the summit-level near the base of these peaks, and, taking advantage of the winding slopes, pass down the right of the creek to Turret rock, to where the park becomes a gorge, and thence be confined to the little valley, from one hundred and fifty to three hundred feet in width, where it could be constructed along the foot of the hills with great ease, and issue with the stream from the mountains upon a broader valley, and, swinging around the base of the hills that set off from the great mountain masses reaching to within a short distance of the Huerfano river, pass through the gorge of that stream, and, taking choice of the great Plains, to and along the Arkansas and Kansas rivers to the Missouri. The supposed distance (for it was not measured) from our last camp, of August 9, on the Huerfano, to the summit of the Sangre de Cristo Pass, by the circuit just indicated, is from twenty-four to twenty-six miles, and the ascent to be overcome, two thousand three hundred and fifty-four feet—an average of ninety-eight feet and one inch to the mile for twenty-four miles, or of ninety feet six inches per mile for the longer distance. On the 13th of August the day was bright and clear, and the mean of five hourly barometrical observations gave us an altitude for this pass, above the sea, of nine thousand two hundred and nineteen feet, which I have used in the estimated elevation to be overcome. "A single grade," says Captain Gunnison, from whose notes I have derived the data for the description of this pass, "could easily be carried from the summit to the gorge of the Huerfano river; but two, one along Gunnison's creek and one on the river, would probably be preferable. Spruce-pine in abundance is at hand on the mountain sides, to supply ties for hundreds of miles of railroad, especially if that which the great fire of 1851 swept over and left standing, killed and blackened, be not left to decay." The small stream called El Sangre de Cristo rises near the summit of the pass, and runs in a general southwestern direction to the valley of San Luis. The valley of this stream is narrow, the stream being lined with thickets of willow bushes, and, winding from side to side, impinges against the base of the hills, forcing us frequently to cross it, or, where it was practicable, to pass over the foot of the hills. The labor of preparing the road for twelve miles was considerable, employing a large force, of which Captain Morris took charge, for four days. We descended from the summit of the pass during the first mile and three-fourths, 178 feet, or about 101 feet per mile; and 549 feet in the next 5.34 miles, or nearly 103 feet per mile. Six miles from this point we left the Sangre de Cristo, and rose to a plain extending along the base of the mountain spurs, which we followed for 4.57 miles, encamping on Utah creek, a short distance below Fort Massachusetts, having descended during the march of 10.57 miles, one hundred and twenty-seven feet, or about twelve feet per mile. By descending from the summit of the pass along the side of the mountains on the right of the Sangre de Cristo, a railroad can be constructed throwing a larger proportion of the descent upon the lower part, where it should curve around a mass of low hills in a bend of the mountains, to the plain just indicated, which subsides gently into the valley of San Luis in the direction of the Coochetopa Pass. The entire descent from the summit of Sangre de Cristo Pass to our present camp, is 854 feet in a distance of seventeen miles. A meridian altitude of the sun, gave us for Fort Massachusetts a latitude of 37° 31′ 59″.

After completing the examination of the Sangre de Cristo Pass, Captain Gunnison made an examination of the mountains to the south of the Spanish Peaks, by ascending Gold branch from its junction with El Sangre de Cristo, to near its head. It is a very crooked stream, coming into the Sangre de Cristo from north 55° east for three miles, then east for one mile, thence winding from the southeast near the mountains beyond Indian and Culebra creeks, and near one of the head branches of the Cuchara. Becoming satisfied, after a long ride, of the exaggeration

J.M. Stanley, from a sketch by R.H. Kern.

Lith. by A. Hoen & Co. Balto.

SANGRE DE CRISTO PASS,

From near the Summit, looking down Gunnison's Creek.

J M Stanley from a sketch, by R. H. Kern

FORT MASSACHUSETTS.

At the foot of the Sierra Blanca. Valley of San Luis.

of the guide, who had represented this route as "without a hill," the party ascended a high peak and looked down upon the extensive plains, over which, for a month, we had wound our way. The view was majestically beautiful, with the Huerfano, Cuchara and Apishpa at their feet, and towering mountains to the north and south, with the valley of San Luis to the west. Descending again to the stream they had left, and finding that about ten miles from its head they were, by barometer, higher than on the Sangre de Cristo Pass, and that the gorge was very winding and narrow, they turned back from their southern course for two miles, and then rode up hill for two hours, much of the way steep and stony, and arrived at the summit of the ridge, "where one could look almost vertically down on the heads of creeks of the Cuchara—one of which winds under Bald mountain, considerably to the south of the Spanish Peaks, where there is a not inviting depression, entirely impracticable for a road." The party passed over fine grassed slopes, and through groves of branching pine and aspen. In descending they came upon a fresh trail, "which had been made by a party of hunters from Taos, who had crossed by the Culebra Pass to the head of the Cuchara, and obtained pack-loads of venison. These men travel a hundred miles, kill the game and pack it on asses, taking from ten to twelve days to procure the load, and four to return to market. They use no salt, and only cover the meat to keep it from the flies. At night they spread out the quarters and saddles on the ground, and lie down among them to protect them from the dogs and wolves. And notwithstanding the daily occurrence of showers about the highest peaks of the mountains, the dryness of the atmosphere is such that the meat is well preserved."

At a late hour, after a fourteen hours' ride, the party arrived at Mr. Williams' herd-grounds on the Sangre de Cristo, Captain Gunnison being quite ill. They dined with the master of the rancho on milk and tole, or parched corn-meal pudding, and slept under his awning on buffalo-robes. Captain Gunnison was quite restored by the kind attentions of Mr. Taplin and his host, from a severe attack of inflammatory rheumatism, which had been greatly aggravated by sleeping out at night with the gentlemen of his party, in exploring the Sangre de Cristo Pass.

The information gained in regard to the snow which falls in El Sangre de Cristo Pass and valley of San Luis, is conflicting. Massalino, our guide through the pass, states that he crossed it in February last, a winter of unprecedented severity and great fall of snow; that he was seven or eight days in making the crossing, which is usually made in two—the dry snow being ten feet deep in the ravines, while the ridges were nearly bare. Antoine Leroux, on the contrary, represents it generally as unusually free from snow for a mountain pass, which can be crossed with facility during the severest storms. The officers of the army stationed at Fort Massachusetts, which is situated just under the Sierra Blanca, in a sheltered valley on Utah creek, about seventeen miles from the summit of the pass, represent the snow, which is usually very dry, to have been in the valley about them, during the past winter, about two feet in depth. Once during our stay in this vicinity, during a thunder-storm on the lower peaks, those more elevated were covered with a beautiful mantle of white. There are no evidences of snow-slides or avalanches about the pass.

Our recent experience in exploring a wild mountainous country without guides, was such as to show the necessity of profiting by the practical lessons in geography gained in the school of the trapper and hunter, by that useful class of mountaineers who have spent many years of their lives in encountering the hardships and imminent dangers hourly incident to their occupation in these fields of savage barbarity, short-lived gratitude and native grandeur, which are annually stained by the sacrifice of some of their number as victims to unbridled ferocity. Accompanied by Lieutenant Baker, I accordingly started on the 15th instant from our camp at the head of El Sangre de Cristo valley, for Taos, in New Mexico, the headquarters of many of the most reliable and experienced of these mountain men. Leaving camp, we passed rapidly down the Sangre de Cristo for ten miles, and entering the broad and extensive valley of San Luis, hemmed in on either side by high mountains, and traversed by the Rio Grande del Norte and its mountain

tributaries, skirted with bushes and a little timber, soon reached the Trenchara, which comes in from the mountains to the east, and is joined a few miles to the west by the Sangre de Cristo, whence it flows on to the Rio Grande. A ride of twenty miles further brought us to the Culebra, or Snake creek. There is a small settlement five miles to the east of the point where we crossed this stream, near the mountains; but without visiting it we continued our journey, and arrived a little after dark, after a ride of sixty-five miles, at the Costilla, a stream similar to the last, on which a new settlement is opened and a few fields are already covered with crops of corn, wheat, oats, and the other usual crops of a New Mexican farm. But the settlement contained no grass, and our Indian bred mules, not knowing the taste of corn, disdained it, much to our regret, for we deemed so long a ride inhuman enough to our animals, without consigning them to a night of abstinence, with a fifty-mile ride before us for the following day. We therefore negotiated for the corner of a wheat-field, the kernel being still soft, and were gratified with the avidity which our Comanches exhibited in feeding on this grain. During the day's ride we had occasionally seen the smokes from the signal-fires of the Indians in the mountains; but they did not molest us, although we subsequently learned that a party of New Mexicans had been robbed by them, near where we saw their smokes, just as we were passing them. The night was lovely and beautiful, succeeded by a bright, clear day. Resuming our way southward in the early morning, at 10 o'clock we passed settlements on streams near the base of the mountains, and at noon arrived at the Rio Colorado, or Red River of the Rio Grande del Norte, where there is a considerable settlement, surrounded by fields of grain. At 3 o'clock we crossed this stream a short distance from the village, and ascended the low, stony, mountain range, which here extends across the broad valley of the Rio Grande, separating the valley of San Luis from that of Taos.

The Rio Grande passes this low range in one of the most formidable cañones existing in this part of the country. Our pathway was thickly shaded by a forest of pines; and the landscape views of the valleys and near and distant mountains, during our afternoon's ride, were among the finest I have ever seen. Fifteen miles from the Rio Colorado we crossed the Arroyo Hondo, or Deep arroyo, from one hundred and fifty to two hundred feet in depth, with fine streams carried in irrigating trenches along its sides to the cultivated fields of the valley, which, from the crest in all directions, appeared, by twilight, covered with fields of grain; and, to shorten our evening ride, we followed on the banks of the irrigating ditches for some distance, until we reached the road leading to Taos, where we arrived at 10 o'clock at night. The valley of Taos is large, and, for New Mexico, extensively cultivated, containing several small villages, of which the principal is San Fernando de Taos, and many farms. It is on all sides surrounded by high mountains, the Rio Grande entering it through a gigantic cañon, and also leaving it through one. The water of the river is but little if at all used for irrigation, the mountain streams being large and more favorably situated. In our ride of over a hundred miles from El Sangre de Cristo to this place, we saw no grass in the valleys worth naming; the vegetation being confined almost exclusively to artemisia and a few varieties of cacti, but chiefly the prickly pear—the pines of the mountains at times extending well down to the plains. In the high small valleys of the mountains the grass is luxuriant and the flowers beautiful. Here, too, showers are of daily occurrence, whilst in the broad valley but little rain falls and nothing can be cultivated except by irrigation. Procuring what information we could of the country westward over which we were to pass, and the services of a guide, we returned in thirty hours to our camp, (which in our absence had been moved but fifteen miles,) by nearly the same route we had followed in leaving it, arriving at noon on the 19th of August. On the following day we were joined by the experienced and well-known guide, Antoine Leroux. Here some half-dozen men came to ask for their discharge, refusing to perform further duty. One who had refused to guard the animals, while grazing in the early part of the day, was discharged, forfeiting arrearages of pay for a violation of his contract. Two others preferred their discharge on the same terms, which was granted; the others returning to their duty. The labors devolving upon Mr. Taplin were too great for his strength, and a due

J.M. Stanley, from a sketch by R.H. Kern.

Lith by A. Hoen & Co. Balt.

SANGRE DE CRISTO PASS LOOKING TOWARDS SAN LUIS VALLEY.

Sierra Blanca in the distance.

regard for his health compelled us reluctantly to part with him here, hoping that the pure air and quiet life of New Mexico would restore him to health.

August 23.—We were detained in making necessary repairs, and in obtaining supplies at Fort Massachusetts, until this morning, when we took leave of the officers of the post, from whom we had received much courteous hospitality; and, following down Utah creek for three miles and a half, crossed it, and passed along the base of the gravelly hills which lie directly at the foot of the Sierra Blanca, southwest and opposite the sharpest peak of which we encamped, at White Mountain spring, seven miles from Utah creek, and, in a direct line over the gravel hills, not more than that from Fort Massachusetts. These gravel hills are a confused set of elevations from fifty to one hundred feet in height, resulting from the washing away of a former deposit and the crumbling of the higher mountain masses. The mountain torrents have washed among them deep channels, and occasional dykes, like vertical walls laid up in regular masses many feet thick, are left exposed. These hills are covered with branching cedars and pines, seldom exceeding twenty feet in height. A few wild hops were observed growing luxuriantly at the crossing of Utah creek.

August 24.—Following the base of the Sierra Blanca on our right, with the broad valley of San Luis on our left, we encamped, after travelling fourteen miles, on a small stream from the mountain, which soon sinks in the plain. The grass along our path was scattered, and we experienced considerable difficulty in driving over the thick masses of sage which cover almost the entire surface of this immense valley. We were here nearly opposite to Roubideau's or Musca Pass. Captain Gunnison immediately proceeded to examine it. It was found impracticable to ascend it with horses, in consequence of one of those great mountain torrents, to which all mountain countries are subject, having swept down it, depositing trees and rocks in every direction, and tearing the bed of the creek, over which two light wagons crossing from the Greenhorn settlement to Taos had descended but a few days before, into holes and gullies ten and twelve feet in depth. For two hours the party toiled up the cañon, sometimes on one side of the creek (which is known as Musca or Fly creek) and then on the other, to the summit, through the upper opening of which they could look down upon the San Luis valley. The course of this ravine from the summit is due west for two and a half miles; then north, 80° west, into the valley. It is 100 feet wide at bottom, with points of the rocky sides jutting into it, making the bed quite crooked. The sides are about 500 feet high, rocky and precipitous, but can be ascended by a footman from the stream at the bottom of the ravine as easily as most lofty mountains can be climbed. The rocks of this pass are chiefly a coarse altered mica slate. The elevation of our present camp above the sea is 7,638 feet, and the difference of level between it and the base of the Sierra Blanca, 6.25 miles distant, 518 feet. From this point to the foot of the pass where it opens into the valley of San Luis, and thence to its summit, there is, unfortunately, a want of clearness in the record of the estimated distances from point to point where observations were made for differences of level. I have therefore taken the largest possible distances which could intervene between these points, presenting the pass in its most favorable aspect. By the direct path which we followed, this distance, between the foot-hills of the mountain and the narrow mouth of the pass, is 1.60 mile—the ascent being 450 feet, or a little over 281 feet per mile. But as these foot-hills are open rolling slopes, the pass could be approached by a much longer path from the south, distributing this elevation over several miles, bringing the grade for a railroad within 100 feet to the mile. But above this point this pass is entirely impracticable for a railroad, and but little better for a wagon road, the ascent being in the next mile and a quarter, 373 feet, and in the following seven-tenths of a mile, 377 feet, while in the succeeding three-fourths of a mile, to the summit of the pass, it is 416 feet; the whole difference of level from the mouth of the ravine to its summit, 2.70 miles, being 1,166 feet, the summit of the pass being 9,772 feet above the sea. No apparent obstacle presents itself from the summit to descending with facility from this pass to the Huerfano river to the north and east; but

the western descent having proved so difficult, no further examination of it was made. *Our guide informs us* that to the west of our trail, along the banks of the Rio del Norte to where it enters a plain through a cañon from the San Juan mountains, bearing west from our present camp, and thence above on its tributaries, the valley of San Luis, which in this part is known to many as the valley of San Juan, is rich and fertile, covered with extensive meadows of grass, and abounding in game and wild horses. The narrow line of timber, thirty-five miles distant upon the Rio del Norte, is plainly seen from our trail; but it is represented to be difficult to cross the valley with wagons, on account of the marshes along the river and the miry banks of the sunken creeks, and we have therefore followed the base of the Sierra Blanca, which extends from the Sangre de Cristo to Gunnison's Pass. To the north of this range, but partially connected with it, a broken range of mountains extends towards the Arkansas river, called the Sierra Mojada or Wet mountain, from the constant rains which fall upon it. The Indian name of the range on the west of the San Luis valley is Sahwatch, but it is more generally known by the Spanish name of San Juan. The San Luis valley is from 40 to 70 miles in width, and still more in length, and so level that trees are seen in any direction, growing on the streams, as far as the eye can discern them.

J. M. Stanley, from sketch by R. H. Kern

Lith. of SARONY MAJOR & KNAPP. New York.

PEAKS OF THE SIERRA BLANCA.

from near Fort Massachusetts

CHAPTER IV.

From Roubideau's Pass, via the Coochetopa Pass and Grand River valley, to the Nah-un-kah-rea or Blue river.—August 25 *to September* 20, 1853.

Gigantic sand-hills.—Williams' Pass.—Stampede.—Sand and sage.—Chatillon, Trois Teton, and Leroux creeks.—Game.—Scene of Colonel Frémont's disaster of 1848–'49.—Vegetation and soil.—Homans' creek.—Currants.—Sahwatch spring and butte.—Coochetopa Pass gate.—Sinking of Sahwatch creek.—Sahwatch valley.—Light dusty soil.—General character of San Luis valley.—Favorable character for a railroad of the lower part of the Sahwatch valley.—Deer, grouse, and trout.—Captain Gunnison's examination of Homans' park: its fertility.—Gunnison's Pass: its position and railroad practicability.—Puncha creek and country east of the pass.—Indicated lines for roads.—Mountain sheep.—Approach to the Coochetopa Pass.—Carnero Pass.—Leaving Sahwatch creek.—Mountain forms, timber, rocks.—Passage and character of the summit of the Coochetopa Pass: altitudes and grades in approaching it, &c.—Method of levelling.—Grades and tunnel.—Existence of a pass north of the Coochetopa Pass.—Valley of Pass creek.—Valley leading to Carnero Pass.—Grades.—Indicated railroad line from the Coochetopa Pass.—Artemisia.—Coochetopa creek.—Pass Creek cañones.—Character of mountain storms.—Grand river: its character, valley, and adjacent mountains.—Confusion of names.—Character of and passage around the first cañon of Grand river.—Tables or mesas.—Brief general description of Grand River valley and cañones.—Fall of the river.—Ice.—Indian smokes and method of hunting.—Captain Gunnison's description of Grand River valley repeated.—Railroad difficulties.—Scarcity of timber.—The guide's dilemma.—Difficulties, character, and passage of Lake Fork.—Delusive basin appearance, exhibiting the broken character of the country.—Effects of mountain air.—View of the Sierra de la Plata.—Utah Indians on Cebolla creek.—Indian presents.—Mountain reconnoissance.—Fine view of distant mountain peaks and adjacent valleys and streams.—Position of the Spanish trail.—Ascent and passage of the mountain.—Ascending and descending grades.—Valley of the Uncompahgra: its cacti, sage, soil, &c.—Utah Indians.—Women of great age.—Domestic scene.—Descent of the Uncompahgra valley.—Utah Indian parties: great numbers in camp.—Indian "talk" and presents.—Roubideau's old fort.—Crossing Grand river.—Difficulties to be encountered in constructing a railroad along the cañon portion of Grand river.—Character of the country below Roubideau's old fort.—Una-weep cañon and creek.—Kah-nah creek.—Nah-un-kah-rea or Blue river.—Steep eastern bank.—River crossing.—River entrance into this valley; its size and character.

August 25.—The examination of Roubideau's Pass being completed this morning, the main body of the party proceeded up the valley, under the command of Lieutenant Baker, while Captain Gunnison, Captain Morris and myself, after leaving this pass, rode to Williams' Pass, the approach to which from the San Luis valley is through a grove of pitch-pine, behind most gigantic sand-hills, rising above the plain to half the height (apparently, at least, 700 or 800 feet,) of the adjacent mountain, and shaped by the winds into beautiful and fanciful forms with waving outlines, for within certain limits this sand drifts about like snow. These immense hills are from eight to ten miles in length, lying along the base of the mountains, and four or five in width, and therefore constitute a great barrier to the western approach to Williams' Pass, directly before which they stand. The stream which flows from it is turned immediately southward, and soon sinks in the sand plain. These hills are so steep and smooth on the side towards this creek, that the smallest pebbles started at their summits roll uninterruptedly into the creek, leaving their paths distinctly marked from the summits to the bases. High up on the sides are seen, at half a dozen points, single bushes of artemisia—the only vegetation seen upon them, and the only change discoverable since they were visited by Captain Pike, fifty years ago, when they were entirely destitute of vegetation, and "appeared exactly like the sea in a storm, except in color."

The course of Williams' Pass as we entered it is N. 58° E., but it soon bends to the left to N. 27° E. We passed up it only about three-fourths of a mile. Its width is about two hundred and fifty yards, rising gradually as far as we could see. Its walls of rock rise on either side to a height of some hundreds of feet, and are nearly vertical. Our guides represent it as continuing for fourteen miles, both in character and direction, as here described; beyond that it is more

abrupt, terminating at its summit less favorably for a road than Roubideau's Pass. It is followed by a large Indian trail. Captain Gunnison did not deem it necessary to pursue the exploration further, and we left this pass having only made our entrance and exit at its western portal. Turning the southern base of the sand-hills, over the lowest of which we rode for a short distance, our horses half burying their hoofs only on the windward slopes, but sinking to their knees on the opposite, we for some distance followed the bed of the stream from the pass, now sunk in the sand, and then struck off across the sandy plain, which here extends far into the valley, and is very uneven, the clumps of artemisia fixing in place large heaps of sand, while the intermediate spaces are swept out by the wind. As we rose a sand-knoll a few miles from camp, we were made aware of its position on Sand creek, by a light cloud of dust raised by the furious charge of frightened horses dashing over the plain; and before we reached it, at dark, we came up with Lieutenant Baker, who had succeeded in recovering all his stampeded horses. Distance 10 miles.

August 26.—Our route lay over the sandy plain to the north of Sand creek, which flows around the north base of the sand-hills, sinking in the plain near our camp. The sand was so heavy that we were six hours and a half in making ten miles—the sand being succeeded, on the last two miles, by a light, friable soil, and heavy growth of artemisia. We encamped on Chatillon's creek, in which we could only obtain water by digging in its sandy bed. A few scattered cotton-woods are the only trees upon these streams, on which willow bushes also flourish. The mountain sides and ravines are dark with low-branching cedar and pine; but they are generally of too small a size to be of any use except for fuel.

August 27.—In our course to-day we approached nearer the base of the mountains on the eastern line of the valley, the soil being still sandy, but much less so than for the last two days. The sage, however, being no less luxuriant, forced us constantly to wind about to avoid the thickest patches. A few small spots of prairie-grass were passed, and marsh-grass grew luxuriantly for a few hundred yards on either side of two small creeks which we crossed, one of which, Trois Tetons, deriving its name from the peaks whence it descends, was so miry that it turned us a mile directly towards the mountains before we could effect a crossing. To our left we could see fine prairie-grass fields, directly in the course to the Coochetopa Pass, for which we were travelling around the valley; but the guide warned us of marshes, and the attempt was not made to cross them. Thirteen miles from camp we reached a fine meadow of bottom-grass a mile in width, extending from the base of the mountains far out into the plain, through the centre of which winds a fine stream of mountain water, named, after our guide, Leroux creek. A few grouse and sand-hill cranes were frightened from their retreat as we came to camp. Deer also were seen here and on the mountain bases a few miles distant. Our hunter supplies us with venison; but while pursuing a wounded buck, an hour ago, was driven in by a bear, which disputed the passage to the prey. The sharp edges and needle forms of the summits of the Sierra Blanca, rising 3,000 feet above the valley, attract much admiration at our camp to-night; and the promising opening in the Sierra San Juan, to the southwest, which allured Colonel Frémont to the disaster of 1848–'49, attracts its full share of attention and comment, some of the gentlemen of our party having participated in that misfortune. The pea-vine and barley-grass grow here, thinly scattered on favorite spots; but the surface of the ground, over large spaces, is often covered with effloresced salts.

August 29.—Our course bore strongly to the west to-day in nearly a direct line for the entrance to the Coochetopa Pass—keeping, however, somewhat to the north to secure a good crossing at Homans' creek, on which we are encamped—there being large marshes further to the south, and the dams of the beaver, which are numerous, flowing the water back to some extent. Our march was only six miles to this fine little stream, with a meadow of grass on each side, of a mile in width. Two varieties of currants, a black and a beautiful yellow, grow in and around our camp in great abundance, and are thought very delicious by the party.

August 30.—Leaving camp we reached Sahwatch spring and butte, by a very direct course across the valley, in ten miles and a half. This spring of pure cold water bursts from the base of the granitic butte which is immediately west of it, but detached from the Sahwatch mountains, to which it properly pertains. Captain Gunnison observed, on the 31st of August, large volumes of air at intervals escaping with the water of this spring. This butte is not high, but its isolation makes it a prominent feature, standing as it does at the puerta or gate of the Coochetopa Pass. It is formed of coarse, gray granite rocks. The spring sends out a fine little stream, winding south and east along grassy fields until it joins the Sahwatch creek, which we reached five miles from the butte in the broad opening leading to the Coochetopa Pass. This stream, which is said to sink before reaching the Rio Grande, flows past our camp over a pebbly bed. It is one foot in depth and eighteen in width, with a rapid current. Its valley at this point is five or seven miles in width, growing narrow towards the west; and there are several isolated buttes standing in it, but none of them of considerable height. A few cotton-wood trees and a margin of willow bushes line the stream. The soil passed over to-day was unusually light and dusty, our horses sinking hoof-deep in it over large spaces.

We here leave the immense valley of San Luis, which is one of the finest in New Mexico, although it contains so large a proportion of worthless land—worthless because destitute of water to such an extent where irrigation alone can produce a crop, and because of the ingredients of the soil in those parts where salts effloresce upon the surface. Its lower portion is adapted to the cultivation of grain, as we have seen at the Costilla and Rio Colorado; and, if its upper part should prove too cold for cereals, its fine fields of grass on and above the Rio Grande del Norte, must make it valuable for grazing. Elevation above the sea 7,567 feet.

August 31.—Five miles from camp the valley narrowed to a few hundred yards in width, and continued so for most of the day's travel of twelve miles. At our camp this evening it is half a mile wide, covered with fine grass, fine bottoms of which we passed several times during the day. We passed, also, a fine grove of cotton-wood half a mile in length, in which deer were bounding about in every direction, even passing between our wagons, which were separated by but a few yards. When ten miles from our morning camp the sand-hills in front of Williams' Pass lay plainly in sight, directly down the valley. We then changed our direction, taking a course for a short distance south of west, on which we are encamped. The hills and mountains enclosing this thus far beautiful valley, vary in height from two or three hundred to twelve or fifteen hundred feet, covered with a scanty growth of small pine. No mountain pass ever opened more favorably for a railroad than this. The grouse at camp are abundant and fine, as are also the trout in the creek, several having been caught this evening weighing each two pounds.

On the morning of the 29th instant Captain Gunnison, and Mr. Homans, accompanied by a guide and four or five men, left the main body of the party and continued up the San Luis valley for fourteen miles to its head, where a small park, into which several small streams flow and unite, forming a single creek, is nearly separated from the main valley by low hills extending from the mountains on either side, into the plain. To this park, which is ten miles in width by fourteen in length, as well as to the creek flowing from it, Captain Gunnison gave the name of his assistant, Mr. Homans, who located them. In this park the party crossed a narrow strip of alkaline earth, sparsely covered with grease-wood, to the most luxuriant fields of grass seen on the trip. This grass covers an area of ten miles by four. Captain Gunnison says, "this is the prettiest, best watered and grassed valley, with wood convenient for fuel, that I have seen in this section. Much hay could be cut, and fine grazing farms opened; and it is also probable that wheat and flax, and perhaps other grains, could be raised." From this park the party proceeded over a pathway of coarse, angular gravel, formed by the crumbling of the quartzose rocks of the hills, by an inclined plane, to the summit of the pass—the object of its present examination—which here divides the waters of the Arkansas river from those of the Rio Grande del Norte. At 1.45 p. m., August 30th, on this summit-

level, the aneroid barometrical record is 22.26, thermometer 81° Fahrenheit; and at 2.40 p. m. 22.23, thermometer 73°; the mean of which referred to our camp of August 27th, 28th, and 29th, the altitude of which is well determined, gives for the altitude of this pass above the sea 8,603 feet. Six miles west from the summit, at 4.30 p. m., the aneroid record is 22.50, thermometer 72°; giving an average descent of fifty-six feet per mile for six miles. Three miles west from this point, at 9 p. m. August 30th, and 6 a. m. August 31st, the records are 22.70, thermometer 50°, and 22.60, thermometer 37°, respectively; giving an average descent of between sixty-seven and sixty-eight feet per mile for three miles, to the centre of Homans' park, from which a railroad can be carried in any direction over the valley of San Luis.

The eastern descent for three-fourths of a mile, was by a steeper path than that by which the party had ascended to the summit, to a spring branch of the Puncha creek, an affluent of the Arkansas, where they encamped, in latitude, by astronomical observation, 38° 25′ 04″. Being without tents, the party found their limited supply of blankets too cool, and rose early, the grass being covered with a white frost—the thermometer standing at 32°, aneroid 22.23; and at 10 o'clock a. m. at this point, thermometer 80°, aneroid 22.35; giving a descent from the summit of the pass of 85 feet, or 113 feet to the mile. One mile and a half from camp Captain Gunnison came to the south branch of the Puncha creek, which is a bold mountain stream; aneroid at 7 a. m. at this point reading 22.50, thermometer 42°; and at 12 m. at the same point 22.64, thermometer 83°; giving an average descent of over 223 feet per mile. But notwithstanding this, the character of the ground is such—broad, open and rolling—that it was deemed practicable by Captain Gunnison to so extend the distance in descending, as to bring the grade within that upon which railroads operate successfully. He descended without difficulty from this point through a cañon four miles in length to the beautiful plains of the Arkansas, ten miles in width, which lie above its cañon, bearing N. 61½ E., magnetic. The aneroid record at this point at 9 a. m., August 30th, is 23.17, thermometer 66°, giving for the four miles an average descent of 185½ feet per mile. Half a mile below this cañon, the north or main branch of the Puncha, descending from high, snowy peaks to the north and west, is joined by that of his path, and thence gradually approaches the Arkansas. Heavy Indian trails attest the frequent use they make of this pass in going to the South Park, and to the Wet Mountain valley, and Hardscrabble, now deserted, and back to the Rio del Norte and Coochetopa regions. And Captain Gunnison gives it as his opinion upon the ground, before any computations were made for grades, that "it affords an excellent wagon and railroad route; the former by Hardscrabble creek, passing around the cañon, or up the Huerfano river; and the latter following the Arkansas river through its cañon." As a testimonial of respect to the memory of the officer who explored it, I have given his name to this pass. On the night of the 30th of August the party returned and slept in Homans' park, and rejoined the main body of the party late this evening, during a slight fall of rain.

September 1.—On the crest of the mountains at day-light—some six or eight hundred feet above us—were a fine band of mountain sheep, some of them large, majestic fellows; but they did not tempt the spirit of the sportsmen among us. We continued on the southern course, on which we encamped last evening, for about two miles, and then turned west, following the Sahwatch creek for six miles, where we crossed it for the last time, and left the main Indian trail which still follows that creek, which rises considerably to the south. This main trail is said to lead through thick forests of timber, through which it would require much labor to open a wagon road to Carnero Pass, equal if not superior to that of our route. We pursued for three miles a fine branch of the Sahwatch, coming in from the north, when we left it, and, turning west, followed a branch of this creek, and after a march of fifteen miles, encamped where a low opening in the mountains afforded a small supply of grass, and enabled us to enter and encamp with our train. The valley of the Sahwatch to-day continued narrow, as at our camp last evening, and the travelling in it very fine, at this dry season. The valley of the next branch was still narrower, varying from 130 yards to 150 feet, and the travelling equally fine; and in the succeeding valley,

J. M. Stanley from Sketch by R. H. Rem

Lith of SARONY & Co. New York.

[illegible] PA PASS.

View looking up Sahwatch Creek; Sept[or] 1st

often narrowed until the huge, fallen rocks from either side had passed each other and lay scattered over the bottom, the road was still good, although we had constantly to wind around these rocks, and to cross and re-cross the creek, here, as almost always under similar circumstances, with soft, springy banks. The pines are confined to the mountain tops and sides, and but few are of respectable size. Surrounding our camp they are small but numerous, extending from our camp-fires quite to the mountain tops. The rocks of the cliffs on all these creeks were porphyritic trapp and igneous rocks of various kinds. The precipitous escarpments of the narrow ravines are of the former stone, very porous, and of a red cast, not unlike, but a shade lighter than the common red sandstone, in formations of from twenty to sixty and eighty feet in thickness. The crests of these bluffs are covered with earth a few feet in thickness, some terminating in larger or smaller plains of table-land, while others are rounded off into points and ridges. In the dry bed of a stream near camp we passed over a sedimentary stratum of coarse sandstone, much water-worn.

September 2.—Captain Morris and myself went forward with working parties, to make practicable crossings for the wagons at the various points where, from the winding of the streams and narrowness of the pass, it should be necessary, and to cut out the timber which at various points quite filled the pass as it covered the ridges, which at this point divide the waters of the continent: those of the eastern slope flowing by the channels up which we have travelled for several days, to the Rio Grande del Norte, and thence to the Gulf of Mexico; while those from the western slope flow into the Rio Grande, or Grand river, one of the main branches of the Colorado of the West, reaching the Pacific through the Gulf of California.

We found little difficulty on the banks of the creek, but were detained some hours by the dense growth of quaking-asp, from the size of saplings to a foot in diameter, among which, fallen in every direction, was an equally large growth of dead aspens. At 11 o'clock, however, we were progressing rapidly towards the summit of the pass, which we soon reached, and, as we enjoyed the prospect before us, a slight thunder-shower was not a disagreeable accompaniment. The elevation of this pass is not enough to give an extensive view, but the numerous small, grassy valleys, and pine and aspen groves of the mountain sides to the west, afforded us a pleasant prospect, the more so as it gave hope of an easy prosecution of our future labors, at least for a time. After cutting away trees for a quarter of a mile down the western slope, we entered an open prairie, at a spring which sends out a fine little creek, which we followed for a mile, without obstruction, and encamped, at half-past 1 o'clock p. m., in a fine field of grass, where two or three mountain rills, coming from as many small valleys, unite. Distance, five miles and a quarter. Latitude, by observation, 38° 12′ 35″.

The width of this pass at the summit does not exceed six hundred yards, but the slopes to the low peaks rising above it are not abrupt. The ascent from the valley of San Luis, by which we reached the summit, was very gradual, increasing with considerable uniformity until we approached it within a short distance, where the ravine of the stream was narrow and thickly timbered; and we left it with the wagons, making an abrupt ascent to the right to the level of the summit, "which we could have reached by an easier grade," Captain Gunnison says in his notes, "by keeping to the left of our track, where the ravine winds gently round to the summit-level." The approximate elevation above the sea of our camp at the Puerta, as we left the valley of San Luis, was 7,567 feet. To our next camp, twelve miles and twenty-seven hundredths above the Puerta, on the Sahwatch creek, we ascended slightly over thirty-nine feet to the mile; and in the next fifteen miles, to our camp 3.83 miles east of the summit, we ascended 913 feet, or nearly sixty-one feet to the mile; our altitude at this camp being 8,960 feet, while the indicated height of the summit itself is 10,032 feet, giving an ascent of 279 feet 9 inches per mile for 3.83 miles; and of our camp on Pass creek, one mile and thirty-three hundredths west of the summit, 9,540 feet—a descent of 492 feet in that distance, or, in whole numbers, 370 feet per mile.

Captain Gunnison describes the system of barometric levelling which he employed on several

sections of the route explored, as follows: "The instruments are kept one hour's distance apart, and record simultaneous readings at the different points of the route. The barometers being first read in camp for comparison, say at 7 o'clock a. m., the party which goes in advance moves forward at once for one hour. At 8 o'clock the barometers are read for altitudes, and the odometers for distances, and the necessary bearings by compass are taken. A small flag is then numbered and planted at this point, when the advance party again moves forward, and at 9 o'clock performs like operations; while the rear readings are made in camp at 8 o'clock, and at 9 at station No. 1, and so on at 10, &c."

By this method of levelling we ascended from our camp east of the summit, 154 feet 4 inches per mile for the first mile and sixty-two hundredths; 215 feet 9 inches per mile for the next mile and thirty-nine hundredths; 396 feet 6 inches per mile for the following fifty-eight hundredths of a mile; and 292 feet on the last twenty-four hundredths of a mile at the summit, or nearly 1,200 feet to the mile. Observations taken for the purpose of ascertaining what extent of deep cutting could be easily effected, gave a descent of 102 feet in the first 350 feet on the eastern slope; and, allowing fifty yards for the length of the summit, an equal distance gave a descent on the western slope of 82 feet. But in constructing a railroad, the level of our camps and path would be disregarded wherever it could be best effected by ascending the hill-sides along the pass, distributing the elevation to be overcome over a longer and more uniform grade. The ravine character of the pass is such, however, narrow and direct, (with sides broken by numerous lateral ravines,) rising to no considerable height above the stream, that the elevation to be thus gained would be thrown entirely upon the last few miles preceding our camp, 3.83 miles below the summit, and could not probably exceed 200 feet. If, therefore, this pass be deemed desirable for a railroad, it will be necessary, after having gained this elevation at this camp, to pass the summit with a grade of 124 feet to the mile, which will require a tunnel, including a deep approach from the west, of not less than two miles in length, entering the hill three-fourths of a mile below the summit on the east, and a short distance above our camp 1.33 mile west of the summit—diminishing the elevation to be overcome by 490 feet. Below this camp the natural grade again becomes practicable for a railroad; for a wagon road this pass is already practicable. In the Sahwatch mountains, to the north of this pass, another pass exists, leading from one of the numerous little branches which we passed after leaving the Sahwatch spring, to the head of the Coochetopa creek, but it is not favorably represented. Captain Gunnison concludes his notes upon this pass by the remark, "that it occupied five hours to cut the road and make the passage of this ridge—the men working hard; and Captain Morris deserves great credit for the manner of executing the labor and selecting the route."

September 3.—We proceeded down the valley of Pass creek in a westerly course, the hills on each side being cut by small rills, deep back towards their summits, which will render a winding route and much cutting and filling necessary in constructing a railroad, for which the southern side of the creek is the most favorable. Four miles from camp we passed a broad valley extending several miles to the south towards the Sierra San Juan, whose northern slopes are still covered with large fields of snow. Opposite this valley that of Pass creek widens considerably, and we passed easily down it for six miles further to where another valley sweeps off to the south, through which a fine creek descends, and, uniting with that of our path, enters a broken cañon. The valley from this point extends to the south towards the snowy peaks of the Sierra San Juan, near which the Sahwatch creek is said to rise, flowing north and east along the base of the mountain to the east of this and the preceding valleys, where its waters approach nearer those flowing into the Pacific than at any other point. The Carnero Pass leads from that creek over this ridge, and its summit does not appear more elevated than that of the Coochetopa, and its western descent much more favorable for a road. Our guide, Leroux, represented its approach from the east, however, as more abrupt than that of the Coochetopa Pass, and did not think it practicable for our wagons to pass through the rocks and timber which

J. M. Stanley From a Sketch by R. H. Kern.

Lith. by A. Hoen & Co. Balto.

SUMMIT OF THE NEAREST RIDGE SOUTH OF GRAND RIVER,
Traversed in passing around lateral Cañones 12 O'clock, Septbr 12.

Sketch by F. W. Egbllstein

Lith of SARONY, MAJOR, & KNAPP New York

VIEW SHOWING THE FORMATION OF THE CAÑON OF GRAND RIVER

near the Mouth of Lake Fork with indications of the formidable Side Cañones.

obstruct it, without more labor than our limited time and the season of the year would warrant us in stopping to bestow upon them; and for the same reasons, no delay was made to examine it. The descent from our morning camp for the first 2.24 miles was (in whole numbers) 108 feet to the mile; 68 feet per mile for the next 2.15 miles; 93 feet per mile for the following 2.05 miles, and 42 feet per mile for the succeeding 3.47 miles.

Captain Gunnison says, "the disposition of the mountains indicates that a line can be carried from the Coochetopa Pass southwesterly for some distance, passing behind the hills which divide the two southern valleys described above, and descending the most western one, securing a better grade than by following Pass creek." This creek here inclines more to the north, and enters a small cañon which sends out several side branches, and we were forced, in turning it, to cross a ridge to the N. N. E. to another branch of the Coochetopa creek. This ridge was rough and thickly covered with several varieties of artemisia—the sage so large and stiff that our animals were very reluctant to pass through it. Distance marched, 20 miles.

September 5.—Following for three miles the narrow valley of the little creek on which we had encamped, either side of which is lined with ledges of sandstone, through which numerous small rivulets have cut deep channels, it is joined by other valleys and spreads out a mile or two in width, and is, whether wide or narrow, covered with abundant grass. On our right we passed a very large, elevated, and remarkably round butte, standing quite detached from the mountain beyond it. Eight miles brought us to the Coochetopa creek, a fine, rapid little stream of twenty feet in width, which we were repeatedly obliged to cross and recross as the valley narrowed into gorges, and the stream impinged against its banks, while to avoid this at other points we passed over the artemisia bluffs. A few cotton-woods were scattered along the creek, but it was generally lined only with willow bushes. At one point where we crossed it, ledges of coarse and crumbling feldspathic granite were observed; but the rocks were generally sandstone, the light-colored argillaceous frequently over-lying the red ferruginous. Conglomerate rocks, but slightly cemented, also prevailed, and a few trap-rocks were seen.

Captain Gunnison ascended a hill one mile W. N. W. from our morning camp, from which he had a fine view of the snow-clad range of mountains from which the Puncha and Coochetopa creeks descend. This mountain extends round by the north to northwest (magnetic,) where Grand river passes between it and the Elk mountains. From this point also he had a view of a snowy peak of the mountains at the head of the Arkansas river, distant in a course N. N. W. perhaps one hundred miles. From this hill he passed over the broken, barren and slightly elevated country along Pass creek, which receives many small cañones from the west, over which it would require considerable labor to construct a road; "but it could be carried over this elevation by rising below gradually for some distance." Numerous elk-horns and buffalo-skulls lay scattered whitening on the hills, attesing the former range of the latter animals to these pastures, where the small variety of artemisia with a camomile odor, of which they are said to be more fond in winter than of any of the grasses, flourishes. Reaching the mouth of Pass creek, we encamped in a meadow of half a mile in diameter, having travelled 15.88 miles. Several times during the day we experienced very sensibly the sudden changes of temperature to which high altitudes in mountain regions are subject from a passing storm or a change of wind—our thick coats being at one moment necessary to our comfort, and the next oppressive. At this season of the year, rain-storms are here always accompanied by thunder and follow the mountain ranges, or gather about their summits, which act, by their icy coldness, as natural condensers. And while I am writing this evening it is snowing on the higher peaks in sight, and a slight shower of rain, accompanied by violent thunder, is falling on the lower ranges. At this camp our altitude was 7,681 feet above the sea—a descent of 1,134 feet from the head of the cañon on Pass creek, sixteen miles distant, or of seventy-one feet per mile.

September 6.—Seven miles from camp the valley of the Coochetopa, which we experienced the same difficulty in following to-day as yesterday, and which was here and there lined with bluffs

Mo. Bot. Garden
1909

of coarse pebbles and boulders, slightly cemented and crumbling, opened into that of Grand river, on the opposite side of which are high ledges of red sandstone—the base of the Elk mountains. This valley, for eight miles after we entered it, is from one-half to one mile and a quarter wide, covered abundantly with grass, the stream being lined with willow and cotton-wood. The bottom is very level, and is evidently annually overflowed at the season of the melting of the mountain snows, the drift of the present season lying scattered in the grass to the base of the hills. The Elk mountains tower high above us to the west, the hills immediately along the valley being high and more or less of a table character, or what the mountain men, of Spanish descent, term mesas—elevated level spaces of land, terminated on one or more sides by precipices and lower levels. Grand river is at present a fine, clear stream of cold water, one hundred feet wide and three feet deep, flowing rapidly over a paving-stone bed. Our guide states that its main branch rises in the Elk mountains to the northwest. This is joined by a large branch from the north which rises in the range of mountains to the west of the headwaters of the Arkansas river, and drains the western slope of that range, and of the Sahwatch mountains. Following the eastern slope of the Elk mountains to their termination, Grand river passes to the south and west of them, where it joins the Nah-un-kah-rea, or Blue river of the Indians and mountain men, which rises in the Middle Park, and is erroneously called Grand river on some of the most correct maps.

We encamped in the valley on the west bank of the river, having marched but 14.75 miles, with an average descent of over seventeen feet per mile. This fine little valley is terminated a short distance below our camp, by the close proximity of the hills on either side, and a deep cañon presents its giant mouth to receive the river.

September 7.—We recrossed the river at our camp, and proceeded down its southern bank 1.80 mile to the head of the cañon, where a small creek enters, which we crossed, and immediately began the ascent of the hills to pass around the deep ravines which enter the cañon in deep chasms. The hills were very rocky, but we found little difficulty in ascending and passing them with our wagons, except from the everlasting sage, which was large and rank, and the only vegetation on them, although we approached quite close to the base of the tables or mesas, which are elevated from 300 to 400 feet above our path, and are separated by deep ravines from a few hundred feet to a quarter of a mile in width. The perpendicular rocks at the head of the cañon are some eighty feet in height, the cañon itself increasing to twice that altitude where a creek enters it from the northwest half a mile below its head. The course of the river in the cañon, for the first mile, is south-southwest (magnetic) and south. It then turns abruptly west, and continues on broken courses towards the southwestern point of the Elk mountains. The rocks are granitic, containing large masses of crystallized quartz, glistening brightly in the sun. After making 3.25 miles over the hills, passing the heads of ravines, we came upon a precipitous descent, the first cañon having terminated, and an open grassy valley succeeding for two miles. We had ascended, in this short distance, 735 feet above the head of the cañon, or 715 feet above our morning camp. We had, therefore, to make, in a few hundred yards, a descent nearly equal to this ascent, on a natural grade of about one foot in five, full of igneous rocks of all sizes, from fragments and projecting masses, to mighty ledges. The loose surface stones removed, we attached ropes to the first wagon, which, to prevent accidents, was held by a number of men. It arrived safely at the bottom of the hill, 547 feet below, and half a mile distant; and we dispensed with ropes, and descended with the remainder of the wagons, separated by a few yards, and soon reached and again crossed the river. This valley was succeeded by another cañon, and we ascended the opposite bank of the river for a similar purpose for which we had labored in the early part of the day. For five miles the ascent was easy, but here we were obliged to cross a deep ravine, and for this purpose were forced close to the base of the mountain to find a practicable descent, which, at best, was very precipitous, as was also the ascent, although not exceeding a hundred yards in length. A mile further on, we again descended to the river, where a narrow strip of grass afforded a night's pasture for our jaded

J.M. Stanley from Sketch by R.H.Kern.

HEAD OF THE FIRST CANON OF GRAND RIVER

below the Mouth of Coo che-te-pa-Creek Sept^br

VIEW OF ORDINARY LATERAL RAVINES ON GRAND RIVER.

From Camp Sept^br 3.

animals, which had been eleven hours in making fourteen miles. One of our wagons had broken an axletree in the passage of the first hill in the morning, and did not arrive at camp until late in the evening. On each side of the river to-day, and, as we can see, for some days ahead, the banks rise rapidly towards the precipitous sides of the mesas, which extend back from fifteen to thirty miles to the mountains. These elevated tables are in classes, each class preserving the same level, though on opposite sides of the river, and consisting of the same formations—all of them terminated at the top by a capping of greater or less thickness of igneous rocks, overlaid by a few feet of soil, on which, occasionally, small groves of trees may be seen. They were formed, doubtless, by the upheaval of large plains at the same time; and the immense cracks and crevices of those convulsions have been enlarged, in time, by the elements, and now form the cañones, gorges, ravines, gullies, and passes, which in every direction surround us. While the current of the river is rapid, and the descent very considerable, these tables seem to preserve the same absolute level, and consequently become more elevated above the river as it descends. They are judged to be, to-day, 1,200 feet above it, and not less than 1,500 twenty miles west of us. Sage alone flourished along our path.

Captain Gunnison rode into the cañones several times during the day. He says of the first, "that it would require blasting one-third of the distance for the construction of a road, and solid masonry, with many arches for culverts on the whole line—a stupendous work for an engineer. The second is less formidable, the rocks being more friable, and the curves of larger radius, while the cliffs are but 100 feet in height." The river, at high water, he judged to cover the bottoms in places to the depth of six and eight feet; and from a neighboring hill, he esteemed the country "the roughest, most hilly, and most 'cut up,' he had ever seen. Hills with flat tops, hills with rounded tops, and hills with knife edges and points, and deep chasms, are on every side." Gray and brown-headed ducks are numerous on the river; the cock of the plains and blue grouse are common, and also deer, antelope, and elk. The average descent of the river from camp to camp to-day was less than ten feet per mile.

September 8.—Last night was clear and cold, ice of some thickness forming in our water-vessels; and the thermometer half an hour before sunrise this morning indicated 23° of Fahrenheit, but the sensation of cold is much less than at a much higher temperature in a moist climate. We were obliged to cross the river twice at this camp to pass around a bluff from a spur of the Elk mountains, and to avoid ravines on the south, which enter the river at a gorge a short distance below. Leroux had gone in advance, leaving a man who had been over the road with him the previous day to point it out to us, but he wandered off in search of mountain sheep, and our pilots, after crossing a spur, descended to the river again, where we lost much time in searching for a ford, the river being narrow and too deep for our wagons; and we were eventually obliged to return to the hills, and follow them for a short distance, when we again crossed to the southern bank of the river, and proceeded immediately from it towards the base of the high tables on that side. We ascended rapidly, having, however, but one sharp ravine to cross, the opposite bank of which we ascended only by dint of hard labor, and descending into another ravine, where we found a small spring of cool water, encamped, with abundant grass on the hills for our animals, having travelled but four miles, our camp being 346 feet above that of the morning, although 200 feet below the crest of the ravine. A large smoke ascending from our last camp, from the grass taking fire after we left it, a larger counter-smoke was seen during the day directly on our route ahead, made doubtless by the Utah Indians, in the heart of whose country we have been travelling for several weeks, and whom we expect daily to meet, as we are approaching their summer hunting-grounds—the elk, which they follow both north and south in the winter, migrating here at this season. Antelope are also abundant, and are taken by the Utahs by building a pen, or rather two sides of a triangle, and driving a large district of country, narrowing in until they themselves form the third side, when they bag the game; and a whipping betides the unfortunate *women*, says our guide, if one happens to escape where they are stationed.

As the train left the river, Captain Gunnison ascended a spur on the north side, whence "a small part of the Arkansas mountains could be seen through the gorge of the river, N. 80° E.; the river itself passing him between square-capped hills, which characterize the spurs on either side, S. 75° W., for perhaps twenty miles. From this position, the reason was apparent why the guides pronounced the further progress of the wagons along the river impracticable." "The stream is imbedded in narrow and sinuous cañones, the dark top outline of which resembles a huge snake in motion, as the wavy atmosphere conveys the light to the eye. And the little spurs appear merged into one great connecting ridge, from the mountains at the head of the Rio del Norte to the great Elk mountains on the north. These spurs have their lowest depressions at the bed of Grand river, a chasm in the porphyritic and crystalline rocks opened for its passage. The red sandstone that has at one time overlaid it, has been washed away. The side creeks from the mountains have cut deep valleys, with perpendicular sides, in the softer rocks; and there are left standing many hills of sandstone, which are protected from decay by what appears to have been lava, cooled under water after spreading over the sediment, which is hardened into argillaceous sandstone in some places, and sand cemented with a ferruginous cement in others. In some parts the capping is removed over great areas, and the stone is found in the bottoms of the streams rounded into pebbles. To look down over the tangent plane to the cañon below, it seems easy to construct a railroad; but immense amounts of cutting, filling, and masonry would be required. There is no timber to speak of nearer than the mountains, and that difficult of access for such a work. Cotton-wood in clumps on the rivers, and dwarf cedar and pine scattered on the cliffs and hills, will furnish fuel for wagoners."

September 9.—For the second time our guide returned to camp last night ill at ease, and it was evident that his two morning's examination of the route ahead had not only proved less successful than he desired, but had quite surprised his memory. But we were too close upon his trail to admit of longer delay in informing us that we had a serious obstacle before us in the passage of the Rio de la Laguna, or Lake fork, coming into Grand river from the south, through almost one continuous cañon from the mountains to the river, and that he had failed to find an easy crossing. This morning, therefore, large working parties of soldiers and employés started forward, under their respective commanders, to prepare the crossing of the creek; and at 2 o'clock p. m. we received orders to move on with the train. Ascending from the ravine on which we had encamped, we were forced high up on the mesas, to avoid numerous deep ravines, which we succeeded in turning successfully, when a short, steep ascent around the rocky wall of the table to our left, brought us, four miles from our morning camp, to the top of the difficult passage—a rapid descent of 4,055 feet in length, and 935 in perpendicular height above the stream, covered with stones of all sizes, from pebbles to tons in weight, with small ledges of rocks cropping out at various points. Some of the stones had been removed in the proposed road; but the wagons, with locked wheels, thumped, jarred, and grated over the greater portion, especially those too large and deeply imbedded in the soil to be removed, until their noise quite equalled that of the foaming torrent creek below. At one point, as they passed obliquely over a ridge, it was necessary to attach ropes to the wagons, and employ a number of men to prevent their overturning. Two hours were thus employed in descending with our eighteen wagons, and in twice crossing the creek, in the bed of which we had to descend for a quarter of a mile, before we could gain a permanent footing on the west side. The creek is sixty feet wide by from one to two deep, with an impetuous current falling with a loud noise over a bed of rocks and large stones. Just above its mouth two fine streams, half a mile apart, enter Grand river from the Elk mountains. Day's march five miles, through a heavy growth of sage.

September 10.—After considerable labor in removing surface-stones and digging down a few yards of the opposite hill, too sideling for our wagons, we doubled our teams, and with ten mules, but not without severe labor—detaining us, however, but six hours—pulled up the load of six to the crest of the western bank of Lake fork, ascending 480 feet in forty-one hundredths of a

mile. By the line followed by our wagons, it is 1.50 mile from crest to crest of the banks of this creek, but in a right line it is only 2,639 feet, or about half a mile, while the perpendicular descent from the east, as already given, is 935 feet. The most practicable means by which this immense ravine can be passed by a road, will be by ascending one of its banks by a heavy grade into the mountains, crossing it by a bridge, and descending the opposite bank—a stupendous labor, for it will be necessary to cut through miles of rocks and to cross large side-ravines. But it becomes narrower below the crossing, and proportionally steeper; and Captain Gunnison, after examining it, thought it, perhaps, *not impossible*, but very difficult to bridge it.

Leaving Lake fork we continued along under high bluffs, over very rocky hills with deep intervening gullies, which forced us southward into a valley gorge, which we reached by a steep ascent, and encamped, after a march of 4.69 miles, under a vertical wall of igneous rocks 100 feet in height, at a beautiful spring of cold water in a fine grassy meadow, through which a creek descends to the river, distant two miles. This little valley is part of a depression some four miles in diameter, like a basin in the high table-land among the mesas, which on all sides enclose it to the eye, although Grand river passes through it, and small streams enter it through deep, wide gorges in all directions. The agreeable and exhilarating effect of the pure mountain air of these elevated regions, ever a fruitful theme of eloquence among trappers and voyageurs, exhibits itself among our men in almost constant boisterous mirth. But violent physical exertion soon puts them out of breath; and our animals, in climbing the hills, unless often halted to breathe, soon become exhausted, and stop from the weight of their loads, but after a few moments' rest move on with renewed vigor and strength.

September 12.—Crossing the creek, we followed the ravine valley of our camp southward to the top of the mesa, and turning westward, passed for two miles along its summit, and descended with difficulty to a creek two hundred feet below, only to ascend again, by an equally abrupt path, to the same level, and again immediately descended, by a similar path, to another creek, difficult to cross only because of the dense thicket of willow bushes which line its banks, and again ascended to nearly the same level as before, and then wound more gradually down a long descent to a larger creek, coming through a deep gorge to the south, from snow-peaks, plainly in sight, of the Sierra de la Plata. We left this creek by a more gentle ascent than we had climbed for a week before, through luxuriant fields of grass, in which, indeed, we had travelled during most of the morning, in rear of the mesa adjacent to Grand river, and passing one or two small ponds of water on the way, descended for five miles to the first branch of Cebolla or Onion creek, the last two miles through a level artemisia field, in which we encamped, on a small grassy space near the creek, having travelled 13.18 miles. While Captain Morris and myself were out in search of a suitable camp, a few Tah-bah-was-chi Utahs exhibited themselves on their war steeds, near enough to call out to us. We advanced to meet them, and a crowd of men, women, and children soon gathered at our camp.

September 13.—Captain Gunnison, this morning, made presents to the Indians; first providing the chief with the articles which he was to distribute to his people, and then a package for himself. They were very importunate for powder and lead, everything else appearing of little value to them. We were anxious to purchase horses, but they would sell them only for arms and ammunition.

We crossed the creek a short distance above our camp, where a practicable ravine afforded us a descent, the bank being forty feet high and very steep, and passing down it ascended the other bank by a similar ravine, opposite our camp, to the rolling sage plain which we crossed to the main branch of Cebolla creek, which we forded, and encamped, after a ride of only 3.75 miles, on a grass field near by, at the base of a connecting mountain range, which here crosses the valley of Grand river from the Elk mountains towards the Sierra de la Plata—it being necessary to find a path for our wagons before attempting the passage. Captain Morris and myself, therefore, with Leroux as guide, and a party of men, rode forward by one of the

two routes followed by Indians and hunters in passing this range, and reached the summit in two hours; the scenery becoming more beautiful as we ascended, especially through the gorge of Onion creek to the south, where vertical columns of rocks stood out high and clear against the sky, being part of the Sierra de la Plata—a range of mountains to the west of the Sahwatch and Sierra San Juan—whose sharp summits are broken into a thousand points and angular forms, and its sides streaked with banks of snow. Our route far behind us lay clear and distinct at our feet to the mountains about the Coochetopa Pass; and the course of Grand river, with the Elk mountains to the north extending round to the northwest with a level summit for many miles, terminating with a vertical descent of a few hundred feet, and then apparently subsiding into a plain. At our feet to the west lay the Uncompahgra river, rising in the Sierra de la Plata, and flowing northwest through a valley of considerable width, beyond which a range of high land was overlooked by more distant mountains, among which the Salt and Abajo peaks were pointed out to us. The former is directly upon the noted Spanish trail leading from California to Abiquiu, New Mexico, and is a favorite resort for the Utah and Navajo Indians for trade; while the latter is near the junction of Grand and Green rivers, considerably below the fords for this trail, or, as Leroux says, below any ford on Grand river known to the New Mexicans, and hence its name. But we had little time to enjoy this majestic scenery, and hastened to examine the descent to the west, which we found very difficult, and at various places, as on the ascent, thickly covered with scrubby oak bushes and aspens. The soil is light, but covered with luxuriant grass. We thought it possible to pass this route with wagons; but the other route, followed by the Indians from our camp to the Uncompahgra, lay directly below us while ascending the mountain, and appeared much preferable to the one we had examined; and a small party, sent out to examine it a short distance, reported it passable.

September 14.—It was 3.80 miles by this route to the top of the steep ascent of the ridge, and three hours were occupied in its ascent; our barometers giving a difference of level of fourteen hundred feet. The top of the mountain was broad, and near the summit we fortunately found a small basin of water, in our circuitous path to avoid ravines, at which our animals were watered; but it was too stagnant for the men. From the western slope the valley of the Uncompahgra could be seen in the distance; and, striking the dry head of Cedar creek, we commenced our descent to it. This creek was too narrow and ravine-like to allow us to descend its bed, and we accordingly circled round on the hillsides, sometimes in grass fields, at others in dense masses of sage, from which we escaped only to encounter the stiff scrubby branches of oak bushes, and at length, through a mass of them, to make a precipitous descent to the creek, which was itself lined with them. Just before sundown we reached a point where Leroux had, under a rock in a deep thickly-bushed ravine, discovered a little cool and refreshing water, with which our animals were watered from buckets, and ourselves supplied for the night, which now overtook us, and we encamped a mile below on a very little coarse grass, having travelled thirteen miles. Two miles west of this camp our elevation above the sea was 6,962 feet, while it was 8,755 feet at the top of the sharp ascent nine miles east of camp. The average ascent per mile to this point, for the 3.80 miles from our morning camp, is a few inches over 368 feet, and the average descent for the succeeding eleven miles is 163 feet per mile. Some additional distance can be gained by a winding path in the ascent of this ridge, but not sufficient to make it practicable for a railroad, which, if at all, can only be carried on this part of Grand river immediately along its banks.

September 15.—We were still forced to cross Cedar creek several times, each passage requiring considerable labor in cutting down the banks, before it became wide enough for our wagons to pass freely down it, which it did two miles below camp, where we found water in pools. To this point the cacti and sage were troublesome, but were scarcely seen again until we reached the borders of the Uncompahgra; the hills and valley alike, on each side of our route, being a light colored, friable, and clayey soil, almost destitute of vegetation. The valley of the

Uncompahgra, efflorescing with salts in many places, is several miles in width, and the stream is lined with cotton-wood trees, willow, and buffalo-berry bushes, and, by crossing it where it was thirty feet wide by one deep, we found an abundance of grass and encamped, having marched 12.30 miles, descending 87.7 feet to the mile for the last ten miles. This river rises, as I have already stated, in the Sierra de la Plata, which appears to set off from the Sierra San Juan, and lie nearly parallel with our path, and from fifty to sixty miles distant. Near us are two or three Indian lodges, the occupants of which were greatly frightened at our sudden appearance. Their young men being absent on the hills hunting, were too timid to return and warn their lodges of our approach, for they had seen us, as we had them, long before reaching these lodges. Those of the women who could, fled to the thickets with their children; but two were too old to run, and were soon assured of their safety. They, however, experienced considerable difficulty in calling the young women from their hiding-places, until their men returned and they no longer feared treachery. The two old women bear unmistakable evidence of having seen the snows of a hundred winters pass away. They are of small stature, and bent forward with years; wearing their coarse hair, still as abundant as in their youth, after the manner of the women of their nation: cut short across the forehead, and, passing below the ears, across the nape of the neck. It is a little thinned on the edges, and stands off hideously ugly, but gray only in a few locks. Their features are dried and shrunken to a mummy-like appearance, with bleared eyes, and sunken lips covering teeth worn to the gums. The joints of some of their fingers are stiff and distorted, and all are enlarged to ugliness. These poor objects of humanity are clothed in ragged, filthy deer-skins, and, on learning that their lives were not in danger, sang and jumped with joy at their escape from what they had supposed inevitable death. The most domestic scene witnessed was that of a mother who visited our camp with her four little children—the five riding the same horse, and all as much at home as mothers and children in a nursery. One sat in front of the mother, and one was swung on her back on a frame covered with skins, and two rode behind her, leaving no place unoccupied from the horse's tail to his neck. Presents were made to these people by Captain Gunnison.

September 16.—We travelled 18.25 miles down the Uncompahgra to-day, crossing the stream four miles below our morning camp, and again a few miles before encamping this evening, a short distance above its junction with Grand river; the descent from camp to camp slightly exceeding forty-one feet to the mile. The country is in all respects like that passed yesterday—cotton-wood, willow, and grass in the narrow bottom, and near it heavy sage; but the great mass of the valley land is nearly destitute of vegetation—light, clayey, and arid to such an extent that it is disagreeable to ride over it, as it sends up clouds of dust at every step. We met several small parties of Indians during the day, all of whom followed us to camp; and others continued to arrive until a late hour at night, filling the air as they approached with yells and calls, which were answered by their friends in or near camp—consisting of inquiries and directions as to how and where they were to pass—until we were heartily tired of them. The most of them were sent out of camp, but they built their fires only a few yards from ours, and their noise was little abated by the change, and our safety but little increased. They had, much to his regret, recognised our guide; but he neither showed fear nor want of confidence in them, although he had once shot one of their chiefs, who was attempting to rob him of his horse; and he shared his fire, pipe, and blankets with the chiefs who remained all night with him.

September 17.—Si-ree-chi-wap, the principal chief of the band, who is now so old that he exercises but little authority directly—intrusting it to his son, who accompanies him—arrived during the night, and, followed by his sub-chiefs and warriors, this morning repaired to Captain Gunnison's tent to talk and smoke. The Captain informed them that "the President had sent him to look for a good road by which his people, who live towards the rising sun, can visit those who live upon the great water where it sets; that the President was their friend, and had authorized

him to make them a few presents in his name." The son of Si-rec-chi-wap replied: "This is your land, and you can go over it at any time. There are bad Indians over the mountains, who kill white men, but the Utahs are good, and glad to see the Americans." Presents were then distributed, pipes smoked, and the party moved on, accompanied for several miles by the chiefs. We crossed the point of land lying between the Uncompahgra and Grand rivers, reaching the latter at Roubideau's old trading fort, now entirely fallen to ruins. The river is much larger than where we left it a week ago; and its water has here a greenish shade, while there it was colorless. The Uncompahgra, however, is remarkable for this color of its water, and for a pea-green moss, two or three inches long, covering the stones in its bed, even where the stream is shallow and very rapid. A mile below the fort we crossed the river at an excellent ford; the bottom being a mile in width, and covered with abundant grass.

The cañon which we have been so many days passing around, terminates several miles above the junction of the Uncompahgra with Grand river, where the latter receives a large affluent from the Elk mountains, known as Smith's fork. The high ridge, varying from 500 to 1,500 feet in height above our path, back of which we passed from Lake fork in avoiding this cañon, and which is itself cut with deep cañones by the Cebolla and other streams, terminates, towards the valley of the Uncompahgra, in buttes and clay hills, of which there are two ridges; the first and lowest, of gray, and the second of red clay, bordering the river. Alkali is seen in these hills, as it is also in the plain, and is doubtless the chief cause of the barrenness of the soil. From our camp below the mouth of the Coochetopa creek, to the junction of Smith's fork with Grand river, there is nothing deserving the name of valley. Now and then there is a small open bottom, from a few yards to a mile or two in length, but at the season of high water the river sweeps over these spaces, and the stream is never followed even by an Indian trail.

The difference of elevation between the head of this cañon section and our camp, a few miles below its termination, on the Uncompahgra, separated from Grand river by a level bottom only, is 2,077 feet; and as the distance between these points by the river does not exceed seventy miles—of which, perhaps, sixty preserves its cañon character—the average descent will vary but slightly from thirty feet to the mile. But from the continuance, for so great a distance, of vertical rocky walls along the river, ranging from 80 to 1,000 feet and more in height, upon which the road must be carried, and which can be cut only by blasting, and, from the deep side-chasms to be passed (as described by Captain Gunnison on the 7th instant) only by the heaviest masonry, it is evident that a railroad, although possible, can only be constructed in the vicinity of this section of Grand river, at an enormous expense—for the accurate estimate of which, situated as the work is at so great a distance from civilization, where not only laborers, but their subsistence, must be transported by land carriage nearly 1,000 miles, and where scarcely a stick of timber has been seen for the last 100 miles on the route, nor will be for the succeeding 150 miles, suitable for a string-piece for a small temporary bridge, or even a railroad tie, it is not too much to say, no data exists, nor will until such a labor shall be undertaken. And it would be a waste of labor to add even a rude estimate of the cost of so impracticable an undertaking.

Ascending from the river bottom, our route passed, parallel with it, over a district of pulverulent clay, the surface occasionally incrusted with salt, with small broken crystals of gypsum scattered freely about. This soil is formed from the wash of the impure clay-slate bluffs, our animals sinking in it to their fetlocks. These bluffs rise one above another until they attain an altitude of 1,000 feet, their summits presenting the appearance, as we descended Grand river, of an unbroken plain; but as we pass in front of them they are seen to be cut into deep ravines by the small streams which descend from them during rains. In a few miles, however, we passed from this soil to a hard one, covered with small fragments of black vesicular volcanic rocks scattered over the surface. The men sent forward to select a camp, failed to find access to the river; and having travelled 20.33 miles at dark, we encamped without water, and on so limited a supply of grass, scattered over the hills, that the most of our animals were tied

up to secure their presence in the morning. Our elevation was perhaps 150 feet above the river, and during the afternoon we had repeatedly to cross deep ravines entering the river in cañones, in trap-rock or in sandstone and clay-slate, where they overlie the trap. The land rises from our camp to the river, distant half a mile, and beyond it is soon elevated into a mountain: the stream flowing, consequently, in an immense chasm along the mountain side, made, doubtless, by volcanic action. Much "cutting and filling" would be required in constructing a railroad near this cañon, which the Utahs call Una-weep, or Red cañon. It extends from a short distance below Roubideau's old fort to near the junction of Grand river with the Blue or Nah-un-kah-rea of the Indians. The Utahs also give the name of Una-weep to a small stream which enters Grand river from the south, in this cañon.

September 18.—At break of day we moved forward for 8.45 miles, over a country like that of yesterday, but less broken, and encamped on a small stream from the west end of the Elk mountains, which are on our right, our course being northwest. This little stream the Indians who visit us call Kah-nah. The grass, though not abundant, is sufficient for our stock. Descent from the Uncompahgra, twenty-nine feet per mile, in round numbers.

September 19.—Four miles and a quarter from camp we came to a small creek, running between clay banks twelve feet in depth, which detained us an hour in crossing. The cañon of Grand river disappears at this point on this bank, and the bottom is covered with a small field of cotton-wood; but we saw no grass either on the creek or river, which is again soon walled in by rocks of sandstone, numerous bluffs of which we passed. The light friable soil of the last two days continued to the Nah-un-kah-rea river, which we reached in a march of 12.32 miles. The eastern bank of this stream, for miles above and below where we struck it, is perpendicular, and from forty to eighty feet in height—the top of clay and the base of shale. A small gully afforded us the means of cutting a very steep path for our wagons to the river, which we crossed a few hundred yards below, at a point where it was but a little over two feet deep and a hundred yards wide, with a clear and very rapid current—the volume of water being twice that of Grand river. The opposite bank, although but six feet high, the moment it was cut down and moistened by the water thrown up by the leading horses, became so miry that we were occupied three hours in crossing, and encamped near the ford—the grass being coarse, and gritty from a recent overflow. This river enters this valley through a cañon or immense gorge, which separates the Elk mountains on the east from the Roan or Book mountains to the west, and, bending from its southern course, unites with Grand river just below us. Roan mountain, which derives its name from the color of its sides of red, gray, white and blue clay, in horizontal strata, destitute of vegetation and washed into many deep gorges and fanciful forms, sweeps round to the west, following a course some miles from the river. The west end of the Elk mountains is terminated with a similar formation; and that to the southwest of Grand river, before its junction with the Blue, resembles it, although more rocky, and some of its bluffs are scantily dotted with small cedars and pines. The valley, twenty miles in diameter, enclosed by these mountains, is quite level and very barren, except scattered fields of the greasewood and sage varieties of artemisia—the margins of Grand and Blue rivers affording but a meagre supply of grass, cotton-wood and willow.

The latter stream at the season of melting snows is greatly swollen, and at every step we see evidences of the great volumes of water which at such times roll forward in its channel or spread out over its bottom, in the deep channels, now dry, and island now part of the main land, covered with huge trees cast up and left by the angry stream. Average descent during the day, nineteen feet per mile.

CHAPTER V.

From Blue River crossing to Green, White, and San Rafael rivers and the eastern foot of the Wahsatch Pass.—September 20 *to October* 13, 1853.

Purchase of Indian horses —Indian veracity.—Soil.—Salt creek.—Indian trails to the Uintas.—Coal bed.—Cañones of Grand river.—Rocks.—Coal —Daily change of temperature.—Aqueous deposits and barrenness of the valleys.—Climate.—Scarcity of cultivable lands.—Leroux returns to New Mexico.—Details of the country between Grand and Green rivers.—Best position for railroad indicated: grades, &c.—Fanciful forms of mountains.—Reach the noted Spanish trail.—Disheartening view.—Ash-heap character of the soil.—Scarcity of water.—Difficulty in the construction of a railroad from Grand to Green river.—Crossing Green river.—Utah Indians.—Character of Roan mountain on Green river.—Spanish trail followed to Akanaquint spring.—Grades.—From Akanaquint spring to White river: rocks, soil, water, and grades.—Ascent of the valley of White river to Clever creek.—Return to White river —San Rafael river.—Return to the Spanish trail.—Course of this trail, and character of the country traversed by it from Akanaquint spring.—Indicated line via the San Rafael.—Improved soil.—Indians subsist on buffalo-berries.—The country between Green river and the Wahsatch mountains: valleys, hills, and rocks. Oak springs.—Indian guide.—Weak condition of our animals.—Grades.

September 20.—Captain Gunnison, for the first time, succeeded in purchasing horses from the Indians with the public goods which had been brought for that purpose.

The horses were small, but hardy, and we were much in want of them. Our camp was moved down the river but 9.10 miles, as the Indians informed us that we could not reach grass beyond that point before night—an artifice to retain good customers; for there was better grass two hours' march ahead, and our animals fared badly on the gritty blue-grass at our camp. Latitude, 39° 07′ 24″; descent, 4 feet 4 inches per mile.

September 21.—The clay soil yesterday and this morning was often very smooth and dry, and so hard that our shod horses scarcely left a mark on it. Seven miles below camp the river again enters a cañon, near which we filled our canteens for the night, and continued on for 7.30 miles over the same greasewood plain to Salt creek, which we found a mere rivulet of miserably brackish water, the sands of the bed being covered with incrustations of salt, which also effloresces widely over the plain. Near this creek the plain is washed into little valleys, leaving small knolls and ridges standing, which give it a rolling appearance; and our men find much labor in cutting down the banks of gullies for the passage of our wagons. Bunch-grass is scattered over the hills towards the river, and our animals drink the creek water freely. Many trails lead up this creek, and the Indians inform us that they are used in visiting their neighboring band, the Uintas. Latitude, 39° 13′ 12″; average descent per mile during the day, 9 feet 7 inches.

September 22.—Captain Gunnison found a bed of coal on a ridge bearing north-northwest from Salt creek cañon, and a mile from it, which he describes as being "100 feet long by 20 broad, and about one foot thick. It is exposed to the weather, but appears to be a good bituminous specimen." Evidences of coal, by the burrows of animals and blackened clay banks, are frequent. Latitude by noon observation, 39° 14′ 15″.

We left Salt creek without a guide—Leroux having gone forward some four days since to examine the route, and show those who accompany him the best road to the Spanish trail, and not yet returned. We determined, therefore, to keep up the broad, rolling valley between Roan mountain on our right, and the cañon bluffs of the river on the left. The day was very hot and oppressive, and the soil friable, with the usual amount of sage and an increase of cacti, with numerous gullies to cut and fill. We found no point at which we could approach the river until too late an hour in the afternoon to reach it with our train, for it was impossible to travel

at night with wagons without a road. We encamped, therefore, without grass, near the dry bed of what proved to be a small intermitting creek of bitter water. Streams of this kind during the day time, in the dry season, contain no water, but small rivulets break out and flow during the night, and again disappear as the sun becomes hot. So many of our animals gave out, that several of the wagons did not reach camp during the night.

We were here about four miles from the river, which, by following the ravine cut through the cañon wall by the creek, was easily reached on horseback, (and only obstructed for wagons by a dry channel cut deep in the clay,) at a narrow bottom of fine grass two or three miles in length, with shady groves of cotton-wood on the banks of the stream. The red sandstone cañon walls are nearly vertical, and two hundred feet high; beyond which smaller ledges rise above each other, terrace-like, for some miles towards Salt mountain, which bears south from our camp, some twenty miles beyond the river. The cañon narrows to the width of the river below the groves of cotton-wood. In a ravine by which Captain Gunnison approached the river, four miles below Salt creek, and nearly opposite the mouth of the San Miguel, he says, "sandstone and clayey deposits alternate one above the other, one layer of which is altered by heat, and much of the argillaceous rock is black with the appearance of coal having burnt under it. Coal is found in the cañon near our camp, and can be gathered in place, and there can be no doubt of this being a part of the Green river coal basin formation; at least, the formation has the same appearance there as here, and the water from the red sandstone and clay deposits similar crystallizations."

We observe the greatest contrast between the heat of the days and nights in these mountain valleys; the thermometer from noon to 3 o'clock p. m. ranging, for the last several days, from 87° to 92° Fahrenheit, and at night falling below the freezing-point. Yet we find a cactus here which flourishes generally in Texas and warm climates.

The barrenness of these valleys is greatly influenced by the alkaline and saline ingredients of the soil, while their dryness is easily understood by observing the distribution of the aqueous vapors. The moment a cloud begins to form, it rushes towards a mountain chain, is poured in torrents upon its highest peaks, and rushes down its rocky sides into the chasms and gutters in which the beds of streams lie in the valleys, too deep and confined to irrigate the adjacent lands to any distance. The higher mountains are also protected by the clouds to a great extent from the powerful rays of the sun, which scorch the valleys; and hence, in inaccessible places to man, grass and herbage flourish. It is not intended to say that no rain falls upon the valleys and plains, but only a very small proportion is deposited there during the warm season, when the rain comes in showers of sudden formation; but in the colder parts of the year more is diffused over the general surface. We have seen rain falling in showers usually in the afternoon, on the mountain-tops, almost every day since we first came in sight of the Rocky mountains, two months since; whilst in this valley for two weeks we have been scorched at midday by a tropical sun, and in the whole distance scarcely moistened, except once or twice, near the summits of passes, by rain.

The formation of the valleys is against a system of artificial irrigation; their absorbing power being so great that the mountain streams, during the summer, seldom reach far into the plains. It is therefore only at the foot of the mountains which are not too elevated and cold for vegetation to flourish, where the small streams descend, that irrigation can be employed. No part of the route thus far from San Luis valley, therefore, offers a spot of any considerable extent suitable for settlement. Sufficient grass flourishes in the mountain valleys of Grand river, east of the junction of the Blue, for grazing purposes; but it is a significant fact, bearing upon the climate, that elk frequent them only in the summer, migrating both to the north and south in autumn, where they remain during the winter, and again return in the summer.

Leroux, with three companions, left us at this camp to return to New Mexico, having completed his engagement as guide. He expects to travel much at night, and trusts to his tact and knowledge

of the country for passing safely through the Indian bands along his route. Day's march, 21.74 miles; ascent, 9 feet 9 inches per mile.

September 26.—Having passed three days in camp, keeping our animals at the river to graze, we this morning resumed our march and determined to continue our course back of the river hills. We were not without hope that the fine rain of the previous night (falling freely for two or three hours) would furnish a supply of water in pools or in creeks from the mountains. At break of day, therefore, I started, accompanied by one man, armed, as I observed after riding some time, only with a spade and hatchet—a gross neglect—to find water, if possible, and grass for a camp; and, if successful, a smoke was to guide the party to the point selected. The first two or three creeks passed within a short distance poured down small muddy streams; but as the sun rose hot and drying, a few hours drained off the surface water, and the beds of creeks soon contained but a few holes of water, and by 10 o'clock even these were fast disappearing. As soon as I had ridden far enough for the day's march, I began my search for grass and water—indispensable items for the camp of a party of exploration, with jaded and weak animals, and months of labor before them. So fruitless was the search, however, that it was not deemed possible to find water; but an extensive view from an elevated position convinced me of the error of deviating from this course, and I therefore made the concerted signal of a camp, trusting to the fortune of a more diligent search; in which threatening showers promised to aid us, and eventually swelled the rain-water creek on which we encamped to the size of a respectable stream, on which and the adjacent hills we found a little bunch-grass. The train arrived, after a march of 16.28 miles, a little before sundown, having passed during the day but one or two small hills and a few gullies. As night closed in, clouds gathered around us; and, as I write, occasional flashes of lightning and steady falling rain threaten us with a comfortless night. Average descent during the day about two feet per mile.

September 27.—It continued to rain most of the night, and increased in violence until 10 o'clock in the morning, when it ceased, and we moved slowly forward over a very slippery and miry soil—all the beds of creeks, recently dry, pouring down torrents of water, and water filling every little depression on the surface of the ground; yet the earth was not moistened more than two inches deep, the wagon-wheels turning up the dry earth onto the brick soft clay of the surface. At 12 o'clock a passing shower sent down such a torrent from the mountain, that, although the leading wagons had crossed it without difficulty, the others were unable to follow for some hours; and we therefore encamped just west of this stream, on a hill finely dotted with bunch-grass, after a march of 5.66 miles. Our route here lies but two or three miles from the base of Roan mountain, and is much more direct from Salt creek than by following the river to the Spanish trail, and thence crossing to the ford on Green river, and is less interrupted by deep gullies; but in wet weather it would be impossible to follow us with heavy loads, and in the dry season no water is known to exist on this path, between Grand and Green rivers.

Captain Gunnison indicates the choice of localities for a railroad track as lying still nearer the base of the mountain, where, however, "much cutting and filling would be required, and many large culverts necessary." The thunder-showers of the morning covered Salt mountain with snow, the effects of which we feel as the wind sweeps round from that quarter, for we can get no wood, and only sage enough to cook our coffee. Ascent, 71 feet per mile.

September 28.—We delayed our march until 8 o'clock, to derive as much benefit from the sun and morning drainage as possible, and it was difficult, even at that hour, to make any progress—mules miring and wagons stalling even on the descent of the hills, which were destitute of a turf or sward, the whole surface to a considerable depth being of the character of stiff brick-yard clay; but after going two or three miles, the soil became more shaly and gravelly on the ridges, and eventually over the whole surface. We descended a steep bluff in the morning, and passed over two gentle swells during the day, the last of which was the divide between the waters of Grand and Green rivers, and after a march of 16.71 miles, in which we descended 12 feet 10 inches

per mile, encamped, just at sundown, on the remnants of a rain-water creek, and a thin supply of grass on the hills. Deep narrow gullies cut in the clay soil, with perpendicular sides, obstructed our progress more than usual to-day, as they were from four to sixteen feet deep, and from one to twelve feet wide.

The mountain on Grand river is very broken, and during the day presented many beautiful rocks standing high above the adjacent ledges and ridges. From one position a majestic shaft stood out clear against the sky; and chimney rocks were almost hourly presented as we rode along, with piles occasionally resembling ruins of immense churches and dwellings, and one or two on eminences, resembling the ruins of mighty cities of adobe buildings.

September 29.—For a mile, in the morning, we continued our course of yesterday, W. S. W., and then changed to S. W. for seven miles, when we came upon the noted Spanish trail which passes the foot of Salt mountain. We then turned W. N. W., following this trail, and encamped, after a march of 14.07 miles, in which we descended 12 feet 3 inches per mile, at a rain-water pool, a neighboring ravine furnishing a limited supply of grass; but, for once, sage was even more scarce than grass, the country being entirely destitute of wood, and presenting only a picture of aridity and barrenness.

From an elevated bluff near camp, Captain Gunnison describes the view as desolate and disheartening in the extreme. "Except three or four small cotton-wood trees in the ravine near us, there is not a tree to be seen by the unassisted eye on any part of the horizon. The plain lying between us and the Wahsatch range, a hundred miles to the west, is a series of rocky, parallel chasms, and fantastic sandstone ridges. On the north, Roan mountain, ten miles from us, presents bare masses of sandstone, and on the higher ridges, twenty miles back, a few scattering cedars may be distinguished with the glass; Salt mountain, to the east, is covered half down its sides with snow; and to the south, mass after mass of coarse conglomerate is broken in fragments, or piled in turret-shaped heaps, colored by ferruginous cement from a deep black to a brilliant red, whilst in some rocks there are argillaceous layers, varying to gray or glistening with white. The surface around us is whitened with fields of alkali, precisely resembling fields of snow. The soft clayey earth in many places glistens with selenite, and gypsum appears in masses along the sharp sides of the bluffs, while fragments of obsidian are scattered over the ground."

September 30.—Our course for six miles this morning was the same as that of last evening, following the direction of the hills and dry beds of creeks. We then passed through the range of hills on our right, and again resumed our course along the base of Roan mountain; these hills presenting precisely the appearance of immense beds and fields of ashes, being more saline and friable even than those of previous days, and even more destitute of vegetation, the undulating descent being relieved near the Akanaquint or Green river by scattered tufts of grass. Groves of cotton-wood lined the stream, and a narrow bottom afforded grass for our animals for the night, after a march of 14 miles. The distance from Grand river to this ford, by a very direct course, is 70 miles, and from Bitter creek, 67 miles by our route, which, except during rains, is entirely without water. By following Grand river, however, some miles below Bitter creek, until the Spanish trail is reached, and, following it, crossing a more broken and gullied country, a spring is said to be passed; but its locality is not known to me. This entire section is, however, not only crossed with great labor and difficulty, but is utterly valueless for occupation and settlement by civilized man.

The greatest difficulty to be overcome in the construction of a railroad on this part of the route, would be in obtaining a firm bed for the superstructure in wet weather; and for this purpose it would be necessary to Macadamize the road very extensively. Average descent, 12½ feet per mile.

Many Akanaquint or Green river Utahs were on the opposite bank as we encamped, and soon crossed it to beg tobacco, and, if possible, to trade; dressed deer-skins being the only article they offer for this purpose.

Our latitude at this camp was 38° 57′ 26″, and our elevation above the sea 3,873 feet; average descent from camp to camp, 42½ feet per mile.

October 1.—We crossed the river by an excellent ford, which we had observed the Indians crossing, from a few yards below our camp (on the Spanish trail) to an island opposite, and from its upper end to the shore. The river is 300 yards wide, with a pebbly bottom, as we forded it, but with quicksands on either side of our path. The water, rising just above the axletrees of our common wagons, flows with a strong current, and is colored by the red sandstone of the country through which it passes, having here the same red muddy character which the Colorado has far below, where it enters the Gulf of California. A fine field of blue-grass, in a grove of cotton-wood just above the ford, and the lateness of the hour, determined us to encamp for the benefit of our animals; but a recent overflow had left a fine deposit of sand on the grass, which made it unpalatable to them.

Indians thronged our camp for several hours. They are the merriest of their race I have ever seen, except the Yumas—constantly laughing and talking, and appearing grateful for the trifling presents they receive. A wrinkled, hard-faced old savage, with whom I shared my luncheon of bread and bacon, quite laughed aloud with joy at his good fortune. They confirmed the report we had before heard, of a war between the Mormons and Wah-ka-ra's (Walker's) band of Utahs, and his absence in New Mexico to dispose of a herd of cattle which he had stolen from them.

The Roan mountain, along which we have travelled for more than a week, extends quite to Green river, and forms one side of the cañon through which it descends a few miles to the north of our present camp. Three miles to the north, if our recent guide is not mistaken, White river cuts the opposite side of this cañon, passing, itself in a cañon, through the southern point of Little mountain, which lies chiefly between White and Green rivers, and forms the western side of the cañon of the latter stream. But in reality Little mountain, which is united to the Wahsatch range on the west, is merely a continuation of the Roan, whose character and appearance at a distance I have described at Blue river. Here, however, we are but a mile or two from its base, and its stratified rocks, nearly horizontal, are distinctly visible, extending on each side of the river on the same level. The mountain itself, as we see it here, is but a few hundred feet high, generally level on its summit; yet there are a few peaks and ridges rising above this common level, but their character is the same as the lower mountain, which has the appearance on the side towards us of recently-broken earth, as though the valley had just been sunken or the mountain thrust up, leaving its sides almost vertical—indeed, quite so with the higher strata, the talus having only accumulated at the base. This mountain wall, however, is very irregular; deep ravines and gorges extend back into it, giving it, with its regular strata presented to us, where no sign of vegetation exists, the appearance of an unfinished fortification, on a scale which is pleasing to the imagination, and contrasts the works of men strongly with those of nature. These walls may be in height from 300 to 500 feet; and its strata, in color, are red, blue, gray, and white. Desolate as is the country over which we have just passed, and around us, the view is still one of the most beautiful and pleasing I remember to have seen. As we approached the river yesterday, the ridges on either of its banks to the west appeared broken into a thousand forms—columns, shafts, temples, buildings, and ruined cities could be seen, or imagined, from the high points along our route. Fifty miles apparently below us on the river, the high snow-peaks of the Sierra Abajo are visible.

Efforts were made to obtain a guide from among the Indians, but no one could be induced by a display of the trinkets, cloths, paints, and blankets they so much covet, to accompany us even to the Wahsatch Pass.

October 2.—Our course this morning, for two hours, was a little south of west, gradually leaving the river. It then gently changed to northwest—our march being 16.76 miles, following the Spanish trail, generally over the same friable soil so often noted; but towards the latter part of the day, along the borders of a creek, in which we found a little standing water, over sandstone

Sketch by R.H.Kern.

Lith. of SARONY, MAJOR & KNAPP New York

VIEW OF THE ROAN OR BOOK MOUNTAINS.

At the Spanish Trail Ford of Green River Oct. 17.

J.M. Stanley from a Sketch by R.H. Kern

Lith. by A. Hoen & Co. Balto.

ROCK HILLS BETWEEN GREEN AND WHITE RIVERS,

Oct.r 3d Wahsatch Mountains in the distance.

hills, the upper strata of which were red, and the lower resembling the yellow argillaceous sandstone of the Arkansas river near Bent's Fort: a few slate ledges also crop out. We passed but very little grass, and but few cotton-wood trees were seen along the dry streams, sage covering the bottoms. At our camp to-night, on the hills, we have bunch-grass, and a fine cool spring of water, called Akanaquint by the Utahs. Average ascent per mile, 35 feet.

October 3.—Travelling sometimes in the bed of the creek, (dry above the spring,) and at others over the rocky, friable soil of the hills, we made but slow progress this morning—about six miles in as many hours—on the Spanish trail. Its course then bore off more strongly to the west, over very rocky, broken hills—and we left it, taking a northwest and a north-northwest course by compass, leaving these rocky hills to the left, and skirting along others to the right, as rocky but perhaps less broken and cut up transversely by cañones. Following for some miles the bed of a dry creek which lies at the base of one of these innumerable bluffs, we eventually came upon the divide between the waters of White and Green rivers, and then, for four miles, descended the bed of another dry creek, running, as before, at the base of immense bluffs of sandstone, and very winding in its course, so that we travelled west, north and east, alternately, and once or twice a little south—encamping just as the sun went down, after a march of 15.77 miles, on a little bunch-grass, where a small supply of saltish water leaks from the strata into the bed of the stream. These bluff ridges were apparently formed by the upheaval of the strata of sandstone, giving a long gradual ascent on one side, while they are broken off on the other nearly perpendicularly; and they succeed each other like rows of bricks laid in a receding manner, with the front ends tilted up and the opposite covered with earth. In a few instances the strata of red, yellow, gray, and white sandstone were observed bent; but they were generally in right lines, with a dip to the east-northeast. We passed occasional masses of conglomerate rocks, and on the hills scattering cedar trees and some fine fields of bunch-grass. The day was oppressively hot as we moved along the bluffs, the sun's rays being reflected with great force until he ceased to shine above the horizon. Ascent per mile, for 4.6 miles, 119 feet, and for 1.14 mile to where we left the Spanish trail, 165.7 feet per mile; but this last distance can be greatly increased. From this point, for 6.08 miles, the grade is upon the summit-level to the south of White river, succeeded by a descent, for 3.96 miles, of 111.3 feet per mile.

October 4.—We followed the dry bed of the creek in which we had encamped for five miles, turning northwest as we approached White river, which we crossed nine miles from camp. This is a small stream, of cool muddy water, eight inches in depth by twenty-five feet in width, with a moderate current. Coarse dry cane-grass covered the bottom, where we came to the river among a grove of cotton-wood and willows; and dense fields of sage formed the border between it and the nearly barren hills. We encamped a mile above the crossing, on the thin bunch-grass of the hills. Average descent per mile, 16.4 feet.

October 5.—Our course for five miles lay along the base of the mountain, with inclined benches intervening some four miles in width, cut transversely by dry mountain streams. White river winds very much among high hills, frequently impinging against their bases, and at various points passing through narrow cañones, rendering it quite impracticable to follow near it. Turning more westerly, we descended a dry creek for two miles and came upon Clever creek, a small branch of White river from the northwest, winding between high hills and bluffs, and encamped after a march of 8.72 miles—being timid about leaving the grass, which was here more than usually abundant. The soil to-day was less friable than heretofore; and the artemisia, except for a half mile just below camp, did not interfere with our progress. The night was cool and the morning chilly, making fires desirable; but before noon the sun was very hot. Average ascent, 41.85 feet to the mile.

October 6.—Our northwest course was continued for four miles and a half, when we left the branch on which we had encamped, turning to the west up a narrow valley, which we followed for some three miles, and then took an Indian trail leading W. S. W., crossing a low ridge to

another creek, which the trail descended for a couple of miles, and then ascended a hill towards White river, until we overlooked that stream just at our feet. But the descent was so steep that we were forced to turn from our southwest course directly north; and were then occupied two hours in descending the half mile of bluff to the river bank, crossing the stream and encamping on the opposite hill, having travelled by an unnecessarily serpentine path, 11.11 miles. The bunch-grass was thin on the hills and in the ravines, and the river-bottom only afforded willow-bushes and dry cane-grass. Buffalo-berries grow in great abundance at our camp, and are esteemed very edible by the party, and are a fine relish when stewed. Latitude, by noon observation, 39° 27′ 00″.4. Average ascent, 23 feet per mile.

The Little mountain, sometimes from the regular appearance and variegated color of its strata, like the Roan, called the Book mountain, lay during to-day's march plainly in view from Green river north and west, to where it apparently joins the first range of the Wahsatch—a low mountain, resembling the former in all respects, which extends around to the west and southwest, White river coming from a low depression in it nearly north of our present camp. Latitude 39° 26′ 48″.

October 7.—The thermometer at sunrise indicated 31°, and at noon in the shade 82° Fahrenheit. Passing from the bluff on which we encamped last night, over rolling barren hills, we entered a small valley coming from the southwest, in which we again came upon the trail we were forced by the hills to leave yesterday, and followed it during the day in a very direct course, passing small pools of water occasionally, and fields of bunch and grama grasses. Our camp, after a march of 13.26 miles, without reaching the summit of the hills drained by White river, is at one of these pools, in the bed of a creek, and the valley and hills promise favorably for our animals to-night. Ascent, 38 feet per mile.

October 8.—Two miles from camp we passed the divide between the waters of the White and San Rafael rivers; and in eleven miles reached and crossed the latter stream, which at present, without the appearance of being swollen, is twice the size of the former, its waters deriving a milky appearance from the clay of its banks. There is not a tree at the point where we crossed this stream; a narrow bottom is covered with dry grass and willow-bushes, intermixed with the buffalo-berry bush thickly covered with fruit. Two miles and a half from the San Rafael we came upon a branch of that river of half its size, with dry grass covering bottom-lands a half mile in width, with the usual bushes and a few cotton-wood trees on the margins of the creek. Captain Gunnison, who was in advance as we approached camp, observed an Indian ascending the opposite side of the valley, and, discharging his pistol, made signs for him to approach, which he did after some hesitation, galloping at a rapid rate with his rifle held ready for action, fearing we were Mormons, with whom he informed us his people were at war, boasting of their feats of prowess. At this camp the cochineal insect was observed on the prickly pear. Day's march, 13.17 miles. At sunrise the following morning the thermometer stood at 26°, and ice formed, in basins of water, a quarter of an inch thick; but before noon the thermometer was again above summer heat. Average descent, 22 feet to the mile.

October 10.—Two miles from camp, in a nearly southern course, we came again upon the Spanish trail, which we left a week ago to avoid the rocky hills which lay in front of us, passing to the north by a route which, from a want of knowledge of what route exactly to pursue to secure the best road and a supply of grass and water, may have been extended too far. We struck lower down on White river than it would be necessary to do if the march from Akanaquint spring to that river could be made in one day, or if water could be found at some intermediate point. The distance from the spring to the river, at a point near the northwest end of the Rock hills, can probably not exceed twenty-five miles. The Spanish trail itself, however, if it can be followed with wagons, is much shorter than the route here indicated; and I see no reason to apprehend any insurmountable obstacle from the appearance of the country, much of which was in view as we passed around it. But the distance from the Akanaquint spring to the San

Rafael by this trail may reach thirty miles; and although there was water on it at a point ten miles from the spring when we passed it, I did not see it, and am not informed as to its permanence. But, as the country is very broken and generally arid, only actual exploration can determine its practicability, which, however, I cannot think more difficult than the route we have followed, and it would certainly not be one-half the distance. The San Rafael also deserves an examination; for if it is practicable to ascend it, a better route might possibly be found to Grand river, from the confluence of the former with Green river, than the one we followed. The soil became more gravelly and firm to-day, while the hills are less difficult of ascent on their bluff sides; but they are equally barren—a few small cedars on the summit of the Wahsatch range, dry grass, willow and berry bushes, with a few cotton-wood trees along the streams, and a few small bunches of sage, being the only vegetation seen on a march of 11.40 miles. The third branch of the San Rafael, called Garambulla by the Indians, of the size of the second, we reached six miles from the morning camp and crossed at our present one. The few Utah Indians who live here seem to subsist almost entirely on the buffalo-berry, the bushes growing on the banks of the creeks in abundance. These berries, which are of the size of currants, grow in great profusion upon the smallest bushes, and are rattled off into skins spread under the bushes. The juice, which is very considerable, is expressed by the hands, and the residue eaten. These Indians are, however, many of them mounted, and we succeeded in purchasing horses from them. Ascent, 25.61 feet per mile.

October 11.—The Spanish trail, though but seldom used of late years, is still very distinct where the soil washes but slightly. On some such spaces to-day we counted from fourteen to twenty parallel trails, of the ordinary size of Indian trails or horse paths, on a way of barely fifty feet in width. Specimens of coal were brought in from the hills near camp, Captain Gunnison and Dr. Schiel differing in opinion as to its quality. A small variety of artemisia—and we have often seen it on the route—grows here in small quantities, of which our mules are quite as fond as of grass. We encamped on Big Rock creek, after a march of 13.46 miles. It is a small stream, destitute of timber. Ascent, 17 feet per mile.

October 12.—Thermometer at sunrise 21°, and 72° Fahrenheit only during the day. The broken valley between the Rock hills, which occupy nearly the whole space between the Wahsatch mountains and Green river, is two miles in width at our last camp, six miles from which we descended a steep bluff, and crossed a small creek as it enters a cañon in these hills. Four miles from this cañon, we reached the foot of a small valley, on the eastern border of which a creek descends from the south from a spur of the Wahsatch range, which sets off to the southeast from the Wahsatch Pass. A series of sandstone spurs, rising one above another, sets down from this southern range, joining the Rock hills to the east, whilst numerous small lateral valleys branch off to the west towards the gorges, among sandstone peaks and tables overlying clay, which form the eastern range of the Wahsatch mountains. These bluish clay cliffs, from two hundred to three hundred feet high, are capped with red and argillaceous sandstone a hundred feet thick, and thence sweep gently up to the summits of the mountains. The soil of the valleys varies from ashy friability, whitened more or less with effloresced salt, to hard clay sprinkled with pebbles—the whole country being utterly worthless. We encamped, having marched 15.65 miles, at Oak spring, which furnished us with an abundance of cool water; and a few acres of dry grass was found on a small stream near by, to which Captain Gunnison gave the name of the commander of his escort, Morris.

Tewip Narrienta, or Powerful Earth, one of our Utah acquaintances of four days' standing, came up with us to-day, having overcome his fear of the Mormons so far as to determine him to accompany us three or four days as a guide. Many of our mules came into camp quite broken down, and, although appearing in good condition, are so weak and leg-weary from months of incessant labor, that it is with great difficulty they can haul our light wagons even a few miles a day. Average ascent, 53 feet to the mile.

CHAPTER VI.

From the eastern base of the Wahsatch mountains, via the Wahsatch Pass and Sevier river, to near the Sevier lake, the most western point of explorations, and back to Cedar springs, after the death of Captain Gunnison.—October 13 *to* 28, 1853.

Akanaquint creek.—Rude figures drawn on rocks.—The Wahsatch Pass.—Character of the hills to the east and west of the pass.—Grades.—Tunnel.—Salt creek.—Swambah creek.—Spanish trail.—Un-got-tah-bi-kin creek.—Col. Burwell and Mr. Ross.—Tewip Narrienta.—Course of the Spanish trail to the west.—Wahsatch mountain reconnoissance.—Salt Creek cañon: its length, character, and grades for a railroad.—Wagon trail.—Entering Sevier River valley.—Moot-se-ne-ah Peak.—Mountains surrounding the Sevier River valley.—Mormon settlements.—Vegetation of the valley.—Sevier river.—Captain Gunnison's statement of the result of his explorations for mail and military roads and for railroads.—Manner in which their duties were performed by the gentlemen of his party.—San Pete creek.—Road from Great Salt Lake to California.—Captain Gunnison's visits to Manti.—Cross the Sevier river.—Lake valley.—Un-kuk-oo-ap mountains.—Fillmore.—Sevier Lake valley.—Rabbit fences.—Return to the Sevier river.—Departure of Captain Gunnison and party to explore the Sevier lake.—Extract from his journal.—Party ascending the Sevier river.—Sand-hills.—River course.—Sage.—Cañon of the Sevier river.—Un kuk-oo-ap mountains terminate.—First intelligence of the disaster to Captain Gunnison's party.—Departure of Captain Morris to the scene of the attack.—Stragglers.—Movement of the train and party to Cedar springs.—Return of Captain Morris.—Scene of the disaster.—Bodies of the slain.—False charges against the Mormons.

October 13.—Passing a low break in a ridge of hills to the south of our camp, after a ride of a mile we reached the Akanaquint, a small mountain brook of two feet in width, running over a stony bed, well skirted with bushes, but without grass. We turned up this creek nearly due west, following its narrow gorge, averaging in width from one hundred to two hundred yards, walled in on either side by high hills of nearly perpendicular sandstones, often water-worn into holes, from which, our Indian guide informed us, the stream received its name. He also told us that a circle in red, high up on a sheltered rock on the face of one of the hills, where some rude human figures are seen, also sketched in red lines, was called Akanaquint. These rude figures, in the place in which they are seen, were a great wonder to him, and he had often attempted to describe them to us during the previous day, telling us that they had been made by an American captain—all chief men of parties are captains with these Indians—who had passed here on his way to California, which the Indians know by the name of Monterey; and, in pointing them out to us, he seemed to think he was showing a remarkable sight. This gorge is cut into deep gullies by streams which pour down from the mountains during storms, which gave us some labor to cross; and a small stream coming in from the south also detained us a short time. But, after following it for two miles and a half, the Spanish trail branches; the southern branch, following the stream, passes over a higher elevation and soon rejoins the northern branch, which, though longer, crosses the mountain at a lower depression. We followed this branch, the hills becoming less high above us, more open and smooth, and covered with dry grass and bushes, and, by a quite gentle and uniform ascent over a fine road, reached the summit of the Wahsatch Pass, the eastern rim of the Great Basin, three miles from the Akanaquint creek. The hills in the immediate vicinity of the summit scarcely rise above the pass, while the country, both to the north and south, as far as the eye can reach, is exceedingly rough. A large range, through which no pass is known to exist, bears off from this pass southeast towards the Sierra Abajo. To the west, but little can be seen over the intervening peaks, except the summits of the mountains, thirty miles distant, on the western border of the valley of the Sevier river.

For two hundred yards the descent of the opposite slope is steep, but was passed with the same

ease as the ascent; and we thence followed a small ravine of dry grass, varying in width from one hundred to three hundred yards, from the summit to our camp. Salt creek issues from springs in this ravine, half a mile from the summit of the pass, and flows into the Sevier (Nicollet) river. It derives its name from the crystallized salt found in the red-clay bluffs of the mountains, its waters being cool and fresh. A few grouse started up as we rode forward, and a large number of sand-hill cranes circled high above the mountains, uttering their peculiar note—pleasant sights to travellers over barren wastes, enlivened by animate nature only here and there, by a pigmy rabbit or a hungry raven. The hills, ravines, and peaks differ materially to the west of the summit from those to the east. Here, although vegetation is entirely withered by frost, it covers the whole face of the country and gives it a pleasant, cheerful aspect; whilst there it is dreary and desolate indeed, relieved only at intervals by scattered sage, the grass of the river bottoms, and more rarely of the hill-tops. A keen northwest wind whistled about us during the day, sharpened by a few drops of rain, icy cold; but our camp-fires to-night burn brightly and pleasantly, the wind having subsided, while our animals have, for the first time for days, entirely ceased their disagreeable cry to feast on the abundant grass.

The narrow sandstone ridge, passed just above our morning camp, can easily be cut for the passage of a railroad. Its summit is 129 feet above that camp, which is distant, in a direct line, sixty hundredths of a mile, which, however, can be considerably increased by taking advantage of the natural formation of the approach. On Akanaquint creek, one mile and eight hundredths above this point, we had ascended but 44 feet. In the next mile and sixty-six hundredths, the ascent is 232 feet, or 140 feet to the mile; and 253 feet in the following one and thirty-four hundredths miles, or 189 feet per mile, while it is 186 feet per mile for the next mile and seventy-four hundredths. From this point to the summit of the pass, it is twenty-two hundredths of a mile; the ascent being 49 feet, or 223 feet per mile. The altitude of this pass is 7,820 feet above the sea. From the summit, the descent westward is 218 feet per mile for the first mile and nine-tenths; and 137 feet per mile for the next mile and seven-tenths; and 202 feet per mile for the following ninety-seven hundredths of a mile to our camp.

The defile character of this pass is such, that it must be approached by the line we followed without material extension, by which, however, a heavy uniform grade of 125 feet per mile can be carried, by a side location on the steep, rocky approach, after reaching the Akanaquint creek, to within one-third of a mile of the summit, where a short tunnel, with deep approaches, will be required—the whole not exceeding three fourths of a mile in length—diminishing the elevation to be overcome by from 175 to 200 feet, and giving a grade of 131 feet per mile for 3.6 miles west of the summit, and thence to the vicinity of our camp, or even less than this, by keeping on the side of the ravine above Salt creek. Latitude, by noon observations, a few hundred yards east of the summit, 38° 45′ 37″.

Salt creek, our Indian guide says, (as well as we can understand him, and the appearance of the mountains confirm his statement,) enters a large cañon two miles below our camp, in a very direct course to the Sevier river. Through this cañon, he says, there is a horse-trail, but that it is impossible for wagons to pass through it without removing the rocks. The stream, to where it enters this gorge, continues its easy descent.

October 14.—Leaving the little valley of Salt creek, while a dense cloud enveloped the mountains, which, however, was soon dissipated by the sun, we passed over a small hill to the south, and almost immediately struck a fine little stream, which we ascended for half a mile, and then crossing another divide to the southwest, reached the Swam-bah, an ice-cold creek, two or three feet wide, falling over a rocky bed. This stream rises to the south in one of the highest ranges in the vicinity, on which are large banks of snow, and flows in a narrow ravine, in a nearly direct line for ten or fifteen miles, as seen from the summit of a high peak ascended during the day. It is densely lined, throughout its entire length, with willow-bushes, interspersed with aspens and a few spruce and pines. The Spanish trail, leading for a short distance up this creek, the guide repre-

sented to be much more practicable than any other for wagons; and we therefore followed it for two miles and three-quarters, to where the trail leaves it. The labor on this short space was very considerable, occupying a large party the whole day in cutting willows and digging down the banks to allow us repeatedly to cross and recross the creek, and to pass along the narrow ravine; two wagons having overturned after the road was deemed practicable. Our progress was five miles during the day, encamping at sundown at the mouth of a beautiful ravine of abundant grass, with fine groves of aspen on the hill-sides—almost the only timber visible in this part of the mountains—for our camp-fires; and the loveliness of our camp, in this mountain vale, is increased by a clear sky and bright moon. Barometers give us an elevation of 679 feet above our morning camp.

October 15.—Rising rapidly for half a mile, the little ravine in which we had encamped terminated, and we ascended its eastern slope by a steep path through a small aspen grove; and then following the ridge, rising still more rapidly for the next half mile, we passed over its summit which divides the waters of the two little creeks of our last and present camps, the Swam-bah and Un-got-tah-bi-kin—an elevation considerably higher than that of the Wahsatch Gap. We then descended into the valley of the last-named creek, which we followed during the remainder of the day, encamping just before sundown at the junction of this with another small creek from the southeast. Here the valley opens to the width of half a mile, and the surrounding hills are much lower than those over which we have been passing. The hills and valleys in every direction sustain the character of those of the last two days, in beauty and in the luxuriance of the grass, and absence of large trees. The labor of preparing the road, though considerable in removing scrubby oaks, pines, cedars and rocks, was much less than that of the preceding day; but we only made eight and a fourth miles from early morning to late evening, having passed a high mountain and descended 1,100 feet below the level of our morning camp.

Colonel Burwell and Mr. Ross, from the party emigrating to California and driving stock for that market, who have continued to follow our route during the summer, from a week to ten days behind us, came into our camp just after dark, with their horses quite broken down from hard riding, having left their party at Green river and taken six days to make the distance which has occupied us for two weeks. Having exhausted their supply of provisions, they have come to us for relief, and will return to-morrow to meet their friends with the small amount we are able to furnish them. I have already noticed their loss of fine horses by a stampede, as we were starting out. A similar misfortune overtook them above Fort Atkinson, on the Arkansas river, attended with the loss of several of their riding-animals. Some of their sheep fell sore-footed while on that part of the route, also, and were unable to travel; and recently, near Green river, they were forty hours without water, and a few of their cattle, coming to water in a miry pool, crowded over each other with such violence that some of them were never recovered from the mire. The Indians on the Uncompahgra had threatened to fight them if they persisted in crossing their country, but, finding they could not intimidate them, did not attempt to execute the threat. On Green river the Indians assisted in crossing the sheep, but had slyly pierced three or four with arrows as they were feeding among the bushes, although they had been presented with half a dozen. They represent their cattle and sheep to be in superior condition, and in passing through the lower settlements in this Territory, they were so represented—a fact which bears directly upon the grass on this route.

Timber upon the mountains, near our camp, alone is wanting to make the evening scenery, in the clear full moon, as delightful as mountain travellers can desire.

October 17.—Our Utah guide, Tewip Narrienta, left us this morning to return to his squaw and papoose, for whom he expressed much fear lest in his absence they might suffer for want of food; but, as they were subsisting when he left them on the still abundant en-carpe, or buffalo-berries, gathered by the squaw, there was no doubt that his anxiety was attributable to our proximity to the Mormon settlements. He repeatedly warned us against these people. His services for the few days that he was with us were valuable; for he was one of the best guides I have ever seen,

and was as good a judge of natural wagon roads as any one, and was of course familiar with his own hunting-grounds.

Crossing the creek near our camp in the morning, we ascended a low depression in a high ridge to the northwest, and descended by a good road for two or three miles, to a narrow ravine. Near the head of this ravine, the Spanish trail turns to the west up another small ravine, and passes over two series of hills, divided by large depressions and creeks, and then crosses the Sevier river, as we are informed, below the junction of its main forks; thence it ascends the San Pasqual, and passes over the west range of the Wahsatch mountains to the vicinity of Little Salt lake "on a route," Captain Gunnison says, and a large section of it was plainly in sight, "entirely unsuitable for a railroad." We continued to follow the Indian trail down the first ravine, which was very narrow and rocky, with a deep channel winding from side to side, which had constantly to be cut to allow the wagons to pass, and for which, rocks, small cedars, and pines had also to be removed.

White, red, and blue clays, and coarse sandstone, formed the sides of the ravine; and it was apparent that, in passing from the district of igneous rocks, we were descending from the fine grazing regions of the mountains to the arid districts of the plains. Eight and a half miles from camp we again crossed Salt creek, which has united with the other small branches we have passed on this slope of the mountains, and is here a fine stream, twenty feet in width, with a strong current. "I have reconnoitred," says Captain Gunnison, "much of this mountain and hilly region while the party has been engaged in its passage. From a high ridge which I ascended on the 14th instant, the valleys of the San Pasqual and Sevier rivers were plainly marked out, and to the northwest a broad opening in the mountains, the passage of the Sevier river, presented itself. On all sides were mountains, peaks, and ridges, abrupt bluffs with white cliffs capping the summits; and the deep cañon, which has driven us over a mountain much higher than the summit of the pass itself, lay three miles to the north. Through this a railroad track might be made, but, owing to the cutting of rock, at a very great expense."

The cañon which we thus passed around, by a circuit of twenty miles, cannot exceed sixteen miles in length; but its walls must be often broken by the entrance of lateral streams, and are not generally perpendicular. The altitude of our camp of the 13th instant, two miles above the head of this cañon, is 6,975 feet, to which seventy-five feet should be added to connect at that point with the estimated grade for a road, which will require an average descent of ninety-five feet per mile for the eighteen miles intervening between that camp and our present position, 1,706 feet below it.

A pleasant sight to us, in crossing this creek, was a few wagon-tracks, after months of toiling without a road, and frequently without trails even, in an unexplored and wild country. These wagons had been here, as we subsequently learned, to procure salt, which is shovelled from the red clay hills, where it is found in the mountains, and is itself red. Following the creek for 2.65 miles, with a descent of ninety-one feet per mile, we entered the broad valley of the Sevier river, leaving the high mountains we have crossed to the east, a beautiful high peak of which, capped with white sandstone or clay, the Indians call Moot-se-ne-ah. To the south, perhaps fifty miles, the valley is terminated by a high cross range, from each end of which a main branch of the Sevier river descends—the eastern being known as the Se-ki-ber, the Indian name of the mountain; on the west a range of the Wahsatch mountains, Un-kuk-oo-ap, extends to the north, until broken by the passage of the river, beyond which, in a low range, it still extends to the north; to the east of this range, and north of our present camp, a fine valley sets off from that of the river, and is watered by several fine mountain streams, tributaries of the Sevier, on which there are considerable Mormon settlements. The width of the Sevier River valley is from four to seven miles, and its length from fifty to sixty, without a tree, and with but little vegetation of any kind, even the sage-bushes being thin and scattered. As we entered it, we bore down the river to the north in search of grass, which is very limited, even in the river bottom, and is confined almost exclusively to its western bank. We encamped, however, on its

eastern bank, on a small field of dry scattered grass, after a march of 14.27 miles, descending twenty-seven feet per mile for the last 3.13 miles, from the foot of the mountain, to the river. The altitude of this camp is 5,019 feet.

The river winds from side to side of an immense ditch, with banks cut perpendicularly in the clay soil, from six to ten feet above the surface of the water. This channel, which may be a hundred yards wide, encloses also the bottom lands and all the grass of this immense valley. The stream is thirty-five yards wide by one deep, with a moderate current; and it winds so constantly in this narrow passage that it is very difficult, standing on its banks, to follow its course with the eye. The bottom lands are but a few inches above the surface of the water, and are annually overflowed. In entering this valley, Captain Gunnison, with two or three men, rode forward, in advance of his party, "and enjoyed the scene extremely. On reaching this plain a stage is attained," he says, "which I have so long desired to accomplish: the great mountains have been passed and a new wagon road open across the continent—a work which was almost unanimously pronounced impossible, by the men who know the mountains and this route over them.

"The result is, a new mail and military road to Taos, in New Mexico, by way of Fort Massachusetts; which, with a little work on Gunnison's creek and a hill near Taos, will be very direct and easy, with excellent feed and water all the way.

"2d. A road for the southern States to California, and for emigrants who are late in starting from the States.

"3d. A military road to, and command of, the Utah country, passing into the centre of the territory of that people at Grand river, from whence radiate trails to all points of the compass.

"4th. It is demonstrated that, for a railroad route, it is far inferior to the Middle Central, by Medicine Bow river, and Laramie plains. It passes some thousands of feet higher, and also lower, and is much longer from St. Louis.

"To the energy, zeal, and ability of Lieutenant Beckwith, and Brevet Captain Morris, in superintending the working parties and conducting the train, the expedition is greatly indebted. That a road for nearly seven hundred miles should have been made over an untrodden track, (except in some places by pack-mules and footmen,) through a wilderness all the way, and across five mountain ranges, (the Sierra Blanca, San Juan, Uncompahgra, Sandstone, and Wahsatch,) and a dry desert of seventy miles between Grand and Green rivers, without deserting one of our nineteen wagons, and leaving but one animal from sickness and one from straying, and this in two and a half months, must be my excuse for speaking highly of all the assistants on this survey."

October 18.—Through the negligence of the men in charge of the mules, they were allowed to wander entirely away from the camp, and some of them were found thirteen miles back on the road near our previous camp. It was half-past 12 o'clock, therefore, before we started on our course down the Sevier river, following the wagon track for eight miles, in the course of which we crossed a small creek coming in from towards the Moot-se-ne-ah Peak, which stands out high and clear against the eastern sky. The wagon track here leading to the northeast, we left it, following the course of the river, and encamped a short distance from it in a fine field of grass on San Pete creek, which flows from the valley containing the settlements to which I have before alluded. Captain Gunnison, who had been out during the day in search of a settlement, returned to camp without having succeeded in his object. Our progress was 11.82 miles; the themometer at sunrise standing at 28°, and in the shade, at noon, at 81° Fahrenheit.

October 19.—After proceeding a mile and a half, we came upon another wagon trail more beaten than the previous one, leading from the San Pete valley directly down the river. Six miles from camp we crossed a small stream with miry banks, the bed of which was lined with a plant emitting a strong pole-cat odor. Four miles from this creek the valley of the Sevier river is terminated by the close proximity of the hills on either side, leaving but little bottom land, and no natural road-way except on the hills, where one can easily be carried. Passing along the hills near the river, among sage and scattered cedar-bushes, we again come to its banks

nineteen miles from our last camp, where we have abundant grass on the right bank of the stream, but it has a strong taste of salt.

October 20.—Two miles and a half from camp we came upon the road leading from the Great Salt lake to California, by the way of Fillmore and Parawan, (Mormon settlements,) the Vegas de Santa Clara, and Walker's Pass, and encamped perhaps a mile above Frémont's point of crossing the Sevier river in 1844. This was a very pleasant autumnal day, for we had not to record a change of temperature from sunrise to mid-day of from forty to sixty degrees, to which we have become so accustomed in these valleys.

Captain Gunnison left us at our camp of yesterday morning, and proceeded up the valley of San Pete, or the northeastern extension of the valley of the Sevier river, to the settlement at Manti City, eighteen miles from that camp. He found the settlers, a hundred families, all gathered into a village for mutual protection against the Utah Indians, who have killed several of the citizens, destroyed their mills, and driven off some of their stock; but this has been accomplished by no means with impunity. A strong guard was posted at this settlement at night. Having procured some necessary supplies and guides (two brothers, G. G. and William Potter) to accompany him to the Sevier lake, Captain Gunnison rejoined us this evening at a late hour.

October 21.—The thermometer at sunrise stood at 14°. The country from our camp to the cañon of the river being broken, and the guides never having passed through it, we crossed the river and followed the California road, passing a low range of hills, within a short distance, into a small valley in the Un-kuk-oo-ap mountains—the Indian name of the range lying in the bend of the Sevier river. This valley, from a small pond which stands several miles to the south of the road, is called Lake valley. To the south of this pond there is said to be an easy pass descending by a creek to the Sevier river. This, if practicable, would lessen the distance considerably from the point where we first came upon the river, westward to this point. Sage grows luxuriantly in this mountain valley, which we followed for ten miles, and passed easily over the mountain lying west of it to the valley of the Sevier lake. The range is finely covered with grass quite down to the sage plains, and is dotted with a growth of small cedar and oak, and is a fine pastoral district. The Sevier valley below the cañon, opens broad to the west and south. We encamped, after a march of 24.18 miles, at Cedar springs, 10.21 miles from the settlement of Fillmore, which is situated on Chalk creek, at the base of the mountains, on a scarcely perceptible slope that descends into the Sevier valley. On the following morning Captain Gunnison visited Fillmore, and returned to camp in the evening.

In crossing almost any of the Basin mountains, long lines of sage-bushes are seen pulled up and thrown on the ground—a single bush in a place, at intervals of a few feet. These lines partially enclose considerable spaces, and are said to be used by the Indians in catching rabbits; but as we never saw them used, it is impossible to understand of what service they can be, for at least nine-tenths of the lines are left open and unobstructed.

October 23.—Yesterday morning, at sunrise, the thermometer stood at 14°; this morning it stood at 15°, and the cold northwest wind which prevailed during the day, gave us a foretaste of winter. Between eleven and twelve o'clock we moved in a northwest direction across the valley towards the Sevier river, our guides thinking it possible that we might find water after travelling seven or eight miles; there being at that point, in the spring, a small mountain stream. We, however, found no water, and continued on towards the river until eight o'clock, when, the night being dark and very cold, we halted, and tied up our animals without water or grass; but their hardship was relieved by a small allowance of corn to each, which Captain Morris had fortunately procured for his animals at Fillmore.

October 24.—As early as we could see, the thermometer standing at 12°, we moved forward, and at ten o'clock reached the Sevier river at a point well supplied with dry grass, which our animals required after a march of 25.43 miles, on which we were engaged for twenty-two hours, over large, rank sage-bushes and a friable soil, occasionally sandy. Indeed, this whole valley, some

fifty or sixty miles in diameter, is one vast artemisia plain surrounded by grassy mountains. Geese and ducks were numerous on the river, and a large herd of antelope were seen yesterday—the first for many weeks. Latitude, 39° 20′ 57″; altitude, 4,692 feet above the sea.

October 25.—Captain Gunnison, with Mr. R. H. Kern, Mr. F. Creutzfeldt, and Mr. Wm. Potter, (guide,) with John Bellows, and a corporal and six men from the escort, left camp at a late hour this morning to explore the vicinity of Sevier lake, supposed to be distant some fifteen or eighteen miles. From Captain Gunnison's journal I extract the description of the country and operations of the party during the day, written after they had encamped for the night: "I came down the river southwest for nine miles, and then, bearing more west for two miles, concluded to encamp, as the water below might prove too salt. The route was through heavy artemisia for five miles, when we came upon more open plains to the nine-mile point, where we met with sloughs alive with geese, ducks, brant, pelicans, and gulls. A few hawks were careering in the high wind, and the black-eared and black-tailed rabbits were very numerous in the large artemisia.

"The mountains wore all day their white night mantle of snow, and we had squalls from the north, with snow falling on the high mountains on all sides of us. Towards sunset it brightened up a little, and our hunters brought in four ducks of as many different varieties."

The remainder of the surveying party left under my charge, with the escort under Captain Morris, crossed the river at an excellent ford at the point of our encampment, immediately after the departure of Captain Gunnison, and, agreeably to his request, proceeded up the river in a northeast direction, encamping at a late hour on the river bottom where it is unusually wide. The river at this point makes a long bend in the plain to the south, passing through drifting sand-hills partially covered with artemisia. We had passed southward to avoid these hills in crossing from Cedar spring to the river, and to-day we passed to the west of the largest of them, yet our route was very heavy and the labor severe on our animals. The day, too, was cold and blustering, with occasional slight squalls of snow in the plains, while in the mountains it fell during the greater part of the day. Those of us who were mounted halted frequently—the wagons coming on very slowly—and built fires of sage, which being resinous burnt very freely, with a large flame for the moment, giving out abundant heat. With the setting sun the wind went down, and the night was clear and cold; and at a late hour the pure mountain snows reflected beautifully the clear light of the waning moon, while all around was quietness and repose. The gap by which the Sevier river passes the Un-kuk-oo-ap mountains is called a cañon; but at this distance—six miles directly in front of us to the northeast—it appears like anything but a cañon passage, although the river may wind from side to side, striking against the foot of the mountains, preventing an easy passage for wagons in its natural state. A large Indian trail, however, passes directly up the river into it. This range of mountains, as seen from our present and last camps, seems to terminate a few miles to the north, leaving a broad, open passage of several miles between it and the succeeding range to the west, in which the waters of the Sevier and Great Salt lakes are divided only by gentle slopes. Distance, 14.27 miles.

October 26.—The morning was clear and cold, and Mount Nebo, seen through the Sevier river gap, with its pure mantle of snow, half enveloped in floating misty clouds, mildly reflecting the rays of the rising sun, presented one of the most beautiful mountain scenes I have ever witnessed. Our animals were kept out to graze until a late hour. At 11 o'clock, however, a party was despatched to ascertain the practicability of the passage around the mountain and thence north to the Great Salt lake; and, without moving camp again until the return of Captain Gunnison, it was intended to examine the passage of the Sevier river the following day. But the first party had scarcely proceeded a hundred yards from camp, when it was met by a man, weak and exhausted, reeling breathless into camp, barely able to communicate, by a few broken sentences, as he sank into a seat, the painful intelligence that Captain Gunnison's party had been surprised in their camp by a large party of Indians, and, he thought, all but himself massacred. Orders were instantly given by Captain Morris, and promptly obeyed by all the men remain-

ing with him of his escort, to replenish their ammunition; and having brought up and saddled their horses, in thirty minutes they were moving rapidly towards the scene of that fatal disaster, hoping to rescue all who might yet survive and perform the last mournful duties of humanity to those who were known to have fallen.

The man who first reached camp was the corporal of the escort, who had made his escape on his horse, and had ridden him until he could go no further, leaving him at our camp of the previous day, whence he ran on foot fourteen miles—twenty-five in all—arriving, without arms, in the condition I have described. Another of the escort reached camp on horseback, before Captain Morris' departure; and two others were met by him in the course of the afternoon, making their way towards camp. The horses of Dr. Schiel, who had accompanied Captain Morris, and of his sergeant and several of his men, gave out during their rapid march, and their riders were left straggling behind; but eventually all arrived safely in camp—the sergeant and some of the men, from their own folly, in a poor plight.

Before Captain Morris' departure the train animals were driven in, with the intention at first of removing the train to a more secure place, with the two young gentlemen, Homans and Snyder, and the teamster force, some of whom were unarmed, to guard it. But it was subsequently determined to break up the camp altogether, and move towards a convenient point, where Captain Morris and myself could meet on the following or succeeding day, and take such measures for future operations as circumstances might require, with better means within our reach than we could command at any other point.

Crossing the river at the camp, we took the shortest line to escape from the sand, which proved far heavier than that of the previous day, but it was 7.44 miles in a southeast course, beyond a border of small cedars a mile wide, among which the sand was so drifted that it was only by innumerable windings and contortions of teams and wagons, that we at last escaped from it and reached the plain of grass a mile or two wide, which here lies on the gradual slope of the mountain. Here we encamped. In crossing the sand-hills numerous fresh Indian tracks were seen, notwithstanding the prevalence of a high wind; but the night passed quietly, and at sunrise we travelled southward along the base of the mountain, hoping to escape a continuation of the sand of the previous day, in which we were only partially successful, however, as it continued heavy for ten miles. We then passed a spur of the mountain and changed our course from south to southeast, and struck the trail we had made in going from Cedar spring to the Sevier river, six miles from the spring, at which we found a large camp of Mormons, on their way to settle at Parawan, near Little Salt lake. Here we encamped and turned our animals out to graze on the hills; the 20.93 miles of to-day being the severest day's labor performed by them, although the day was cool, during the whole course of our long summer journeyings. The last of our animals were not out of harness when Captain Morris arrived, confirming our worst fears for the fate of our late comrades.

Captain Gunnison had encamped early in the afternoon, while the wind and storm were yet fresh, and doubtless feeling the security which men come to indulge after passing long periods of time surrounded by savages without actually encountering them. The abundant grass and fuel of a little nook in the river bottom, sheltered by the high second bank of the river on one side, and thick willows, distant scarcely thirty yards, on two of the others, with the river in front, offered a tempting place of comfort and utility, which was perhaps accepted without even a thought of danger. It was known to the party that a band of Indians was near them, for we had seen their fires daily since entering the valley; but an unusual feeling of security against them was felt, as Captain Gunnison had learned that a recent quarrel, resulting in several deaths, which they had had with emigrants, had terminated, and that notwithstanding this difficulty they had remained at peace with the neighboring settlers, which had been confirmed and guarantied for the future in a "talk" held with some of the Indians of this band, by an agent of the governor of the Territory, during our stay near Fillmore. This information, Cap-

tain Gunnison told me before leaving, relieved him from any apprehension he might otherwise have felt regarding this band, and was the reason for his having asked for so small an escort to accompany him, which he as well as his guide, an experienced citizen of the Territory, deemed sufficient.

The usual precaution of a camp guard had been taken, each of the party (including the commander) in turn having performed that duty during the night. At the break of day all arose and at once engaged in the usual duties of a camp preparatory to an early start, to reach that day the most distant point of exploration for the present season. The sun had not yet risen, most of the party being at breakfast, when the surrounding quietness and silence of this vast plain was broken by the discharge of a volley of rifles and a shower of arrows through that devoted camp, mingled with the savage yells of a large band of Pah-Utah Indians almost in the midst of the camp; for, under cover of the thick bushes, they had approached undiscovered to within twenty-five yards of the camp-fires. The surprise was complete. At the first discharge, the call to "seize your arms" had little effect. All was confusion. Captain Gunnison, stepping from his tent, called to his savage murderers that he was their friend; but this had no effect. They rushed into camp, and only those escaped who succeeded in mounting on horseback, and even then they were pursued for many miles. The horse of one fell near camp, tumbling his rider under a bush, where he lay for six or seven hours, while the Indians were passing him on every side, until finally he could no longer hear them near him or in the camp, when he left, and was met soon afterwards by Capt. Morris' party, which reached the fatal spot just before night. Two Indians were seen a mile or two from camp by Lieutenant Baker and Mr. Potter, brother of the guide, but they were not able to come up with them before night enabled them to escape. The bodies of the slain were not all found at dark, and hope still lingered as a bright fire was built to assure any survivor of safety. But the long weary night, rendered hideous by the howling of wolves, wore away, as this little band of armed men, barely larger than that which had already been sacrificed, lay near the fatal spot, and day dawned only to discover the mutilated remains of their recent comrades, none of them being scalped—a barbarity which some of the tribes on this part of the continent seldom indulge. Some of their arms were, however, cut off at the elbows, and their entrails cut open; and, the wolves having had access to them during the day and to those exposed during the night, their bodies were in such a condition that it was not deemed possible to bring them away—not even that of Captain Gunnison, who had fallen pierced with fifteen arrows.

The statement which has from time to time appeared (or been copied) in various newspapers of the country since the occurrence of these sad events, charging the Mormons or Mormon authorities with instigating the Indians to, if not actually aiding them in, the murder of Captain Gunnison and his associates, is, I believe, not only entirely false, but there is no accidental circumstance connected with it affording the slightest foundation for such a charge.

CHAPTER VII.

From Cedar Spring, by way of Nephi, Payson, Palmyra, Springville, Provo, Pleasant Grove, Lake City, Lehi, Willow creek, and Cottonwood settlements, to Great Salt Lake City — October 28 to November 8, 1853.

Pioneer creek.—Citizens of Fillmore.—Messrs. Call and Richards —Express to Great Salt Lake City.—Courtesy and assistance from Mr. Call and Governor Young.—Papers and property recovered.—Kenosh's account of the murder.—Excitement of our men.—Course from the Coochetopa Pass to the Wahsatch Pass.—Character of the country from the Wahsatch Pass to Little Salt lake and Vegas de Santa Clara: its impracticability for a railroad.—Railroad following the Sevier river.—Western limit of the explorations of 1853.—Unobstructed passage from Sevier lake to Great Salt lake.—Return to Sevier river.—Appearance of Sevier River cañon.—Village of Nephi.—Payson.—Spanish fork.—Palmyra.—Provo.—Timpanogos river.—Western range of the Wahsatch mountains.—Line of Mormon settlements.—Supplies purchased.—Lake Utah.—Reference to Stansbury's Report.—Winter camp.—Condition of animals crossing the Plains.—Winter quarters at Great Salt lake.

October 28.—We moved our camp to Pioneer creek, three miles southeast of Cedar spring, to obtain better grazing for our stock. Messrs. Snow and Richards, from Great Salt Lake City, travelling on a mission to the lower settlements in the Territory, called at our camp.

October 29.—A party of the citizens of Fillmore, headed by their president, Mr. Anson Call, and accompanied by Mr. Richards from Great Salt Lake City, came to our camp to request Captain Morris to furnish the particulars of the disaster of the 26th instant, to be forwarded by express to the governor of the Territory of Utah, which express could also take dispatches, for the War Department, to Great Salt Lake City, in time for the mail of the 1st of November—which would be the last that could be depended upon to reach the States before the next spring—provided these dispatches could be furnished within two or three hours. Hasty notes were accordingly written, without time to take copies for future reference, and reached Great Salt Lake City, at a reasonable expense to the government, just in time for the mail.

President Call and Mr. Richards, taking an interest in the survey, tendered us all the aid within their power, and the former voluntarily took upon himself the task of recovering from the Indians the papers and instruments they had captured; for which I furnished presents to reward the exertions of the friendly Indians who were to be employed.

These efforts of Mr. Call proved entirely successful, and we had the pleasure, a few days subsequent to our arrival at Great Salt Lake City, of receiving at the hands of the agents of the governor of the Territory, Brigham Young, who had received them from Mr. Call, all the notes, most of the instruments, and several of the arms lost—the latter much injured, but the former in good condition. Several mules and horses were also recovered, some of them at a later day by Indian agents, acting under the Governor's instructions. Governor Young, immediately on the receipt of the intelligence of the massacre, dispatched a party to the scene of the tragedy to bury the dead, and, if possible, remove the remains of Captain Gunnison and others, and recover the property captured in the camp. In the last object, however, as I have stated, he had been anticipated; and in the kindly office of the first, unfortunately, the wolves had left but the slightest traces of the remains of the dead to receive the solemn rite of burial.

October 30.—Kenosh, the chief of the band of murderers, arrived at Fillmore, having been sent for by Mr. Call, accompanied by fifteen or twenty of his people. He brought with him one of the public horses lost by Captain Gunnison's escort, "which," he said, "he had taken from the fellow who came to him with the intelligence of their successful operation, and hastened to return it, meeting Mr. Call's messenger (who had been sent for him) on the way; that he deeply regretted

the tragedy; that it was done without authority, by the young men—boys, as he called them—of the band, who had no chief with them, or it would not have happened." He subsequently informed the Governor's agent that there were thirty of his people in the party, two of whom were its instigators, seeking revenge for the death of their father, who, they said, had been killed by emigrants but a few days before.

A few of our men were in Fillmore on the arrival of Kenosh, and caused the authorities some apprehension—Captain Morris receiving a note from them, deprecating the indignation of our men against the Indians, and hoping we would restrain it within killing limits—fearing that they would retaliate upon the exposed settlers after our departure.

It will be observed that we have been forced much further north in our course west from the Coochetopa Pass than had been anticipated when the instructions were issued fixing the vicinity of the Vegas de Santa Clara as the western limit of the survey. The pass in the Wahsatch mountains was also found considerably to the north of its anticipated locality, and the broken and mountainous character (given by our recent guides, and confirmed by observations from the summit of the Wahsatch mountains) of the country intervening between this pass and the Little Salt lake and Vegas de Santa Clara was such that Captain Gunnison deemed it impracticable for a railroad, but, if practicable, by no means desirable, as, in his opinion, it would necessarily increase the distance from the Wahsatch Pass to any known pass in the Sierra Nevada beyond what it would be by passing down the Sevier river and north of the lake of that name. He determined therefore to descend this river to the vicinity of the Sevier lake—a point considerably to the north of the Vegas de Santa Clara, but in nearly the same longitude; and thence turn northward, on a return route by the way of Lake Utah. In our course down the Sevier or Nicollet river, as has been seen, we crossed it on its northern bend, and thence passed over the range of mountains which it partially encloses, to the broad open plain of the Sevier lake, and again crossed to the right bank of the river. No other than the most ordinary obstructions exist to the construction of a railroad from the foot of the Wahsatch Pass to the western point of our explorations, passing the Un-kuk-oo-ap mountains through the gorge of the Sevier river; for, although we did not pass through this cañon, as it is called, we could see entirely through it at either end as we passed it. It is apparently without walls, but the mountains rise abruptly from the river bank. Twenty miles perhaps to the west of this point mountains are again seen, apparently in detached broken masses. To the north, as before stated, no obstruction could be seen to an easy passage to the Great Salt lake.

October 31.—We re-crossed the Sevier river, encamping half a mile north of our camp of the 20th instant. Distance, 28.24 miles.

November 1.—Following the road in a general course a little to the east of north, at a short distance from the river, a broken range of hills intervening for three or four miles, we came opposite the upper end of the Sevier River cañon, which appears no more difficult of passage from this than the opposite end. Nine miles from camp we passed a small creek, spreading out in some places into little sheets of water, covered with ducks and lined with grass. It breaks through the high hills to our left in its course to the river. We travelled up its valley, along the course of the mountains on our right, for ten or twelve miles; and, by an almost imperceptible change of level, came upon the slope towards Salt creek, which we reached, after a ride of 24.85 miles, at the small settlement of Nephi. Seventy men with their families constitute this settlement, which, on account of Indian depredations, is concentrated at present in a little village—each settler bringing in with him, not only his ricks of corn and hay, but his little log-house. Salt creek, which runs into Utah lake, descends from a cañon of the mountain just to the east of the village, directly at the southern base of a high peak called Mount Nebo. The creek takes its name from salt springs on its banks.

November 3.—Passing northward down Salt creek at the base of the mountains, we crossed Willow creek eight miles from Nephi, and three or four fine springs eleven and a half miles from

that place, one of which sends out a fine bold stream of cold water. Just below these springs Salt creek finds a passage through the small ridge to the west, and the road ascends a low divide, from which we had the first view of Utah lake; and a little distance from the divide we came upon Summit creek, nineteen miles from Nephi, where a small settlement has been broken up by the Indian difficulties. Three miles from this we passed another fine creek, with cultivated fields to the left of the road, and encamped at Payson, a fine little village on a stream called Peteet-nete, 25.18 miles from our morning camp.

November 4.—Five miles and a half from Payson we crossed the Spanish fork, where it was twenty feet wide and two feet deep; a mile and a quarter from which we passed through Palmyra, a fine settlement irrigated by the waters of this stream. The road was very tortuous, winding around fields, irrigating ditches, and spring places in the level valley of Utah lake, which was just on our left. Thirteen miles from Payson we passed through Springville, on Hobble creek—an older and finer settlement than we had before seen, with some good adobe houses, a few of which were of two stories. The road then followed close along the base of the mountains for 6.37 miles, to the settlement of Provo, on the Timpanogos river. This river, at the present low stage of water, runs in several small stony channels, so divided that it is not easy to give its dimensions; but its current is deep and rapid, with at least double the volume of the Spanish fork. The cañon of this stream is two or three miles northeast of this settlement. It is narrow at the bottom, but appears favorable for the construction of a road hence to Kamas prairie.

The western range of the Wahsatch mountains, (at the western base of which we have been travelling for several days,) standing on the eastern border of the Great Basin, is continuous, extending north and south over five degrees of latitude, from the vicinity of Little Salt lake to north of Bear river, broken only by the passage of the Sevier, Timpanogos, Weber, and Bear rivers. Their altitude, at 3,000 feet above the general level of the country, is quite uniform; but it occasionally falls down to 2,000, and at a few points rises to 4,000 and 4,500 feet. Their western slope is very steep—often inaccessible—presenting generally a formidable barrier to the entrance of a railroad into the Basin from the east. Many small streams descend from them; and as far as their disintegrations have been deposited at their base upon the alkaline plains of the Basin, it forms a rich soil. This line of deposit is narrow, and not continuous, but varying in width, where it is found, from two or three miles to ten or twelve at a few points, as opposite Utah and Great Salt lakes, where it occupies the entire space from the mountains to the lake shores. It is to this narrow belt of land that the Mormon settlements are almost exclusively confined, the isolated settlements being upon similar deposits in small valleys at the bases of other mountains, the small mountain streams upon which, of course, these deposits are the richest, and chiefly exist, being used for irrigation. Respectable crops of wheat and oats are produced, and barley has been cultivated to some extent; but corn does not flourish well. The grass of this district and of the higher mountain valleys is excellent; and potatoes and other roots are produced in abundance, and of a superior quality.

Supplies were freely furnished to us by the authorities of the settlements through which we passed, at reasonable rates.

November 5.—Leaving the Timpanogos river, we ascended a high bluff to a table extending along the base of the mountains. The road for eight miles was very fine, and the view of Utah lake the best we had had, reminding us of those of western New York. It is twenty-five miles in length, north and south, by twelve in width, with fine, irrigable lands on the east, and pasture lands on the west; the whole enclosed by high mountains, with low passages to the south and north, through the latter of which its outlet, the river Jordan of the Mormons, descends to Great Salt lake.

Coming opposite the ravine from which Battle creek descends, we again passed to the lower level, passing through the village of Pleasant Grove to that of Lake City, on the American fork, which is a few miles nearly east from the foot of the lake. Altitude, 4,596 feet above the sea.

November 6.—We passed Lehi settlement on Dry creek, and, eight miles from Lake City, ascended a small ridge, along the side of which, towards the river Jordan, the road is cut in gravel banks, passing from the valley of Utah lake to that of Great Salt lake.

For the description of this valley I beg to refer you to the survey and able report of Captain Howard Stansbury, of the corps of Topographical Engineers, made in the years 1849 and 1850.

On the 8th of November our party arrived in Great Salt Lake City, and on the 12th the animals were sent to graze for the winter, in charge of a strong guard, in Cedar valley, a few miles west of Utah lake.

The season of the year was so much advanced, and the condition of our animals—especially of the American grain-fed horses, upon which the escort was mounted—was such, after our long summer's labor, that it was Captain Gunnison's intention, had he survived, to have terminated his field operations for the present season by the examination he was engaged upon at his death, and by a reconnoissance, more or less minute, of the cañon of the Timpanogos river. He would then have taken up quarters for the winter, and have prepared and submitted a report of the explorations of the summer. The expediency of this course will be manifest, and its necessity evident, from the fact that our train animals for subsistence transportation were unfit to leave this valley without a rest of several weeks on fine pasturage, and that several snow-storms had already occurred in the Wahsatch mountains directly on our course east, and that it is impossible to cross these mountains, where there is no road, with wagons, while they are covered with a heavy fall of snow. To avoid the loss of time, therefore, in recruiting the animals, and the risk of crossing the mountains with our train in winter, Captain Gunnison had determined upon the course I have indicated.

The severe labor performed immediately after the disaster resulted in the loss of several of the escort horses, and further reduced the condition of all of our animals; and in this connexion it may be proper that I should add, that, in my opinion, (formed upon observation,) the service which horses, which for any considerable time have been accustomed to feeding on grain, are capable of performing *west of the Plains*, *soon after crossing them*, is trifling. Such horses require several months' rest, and grain forage, to recover from their weak and emaciated condition. The horses of Captain Morris' command entered this valley in fine condition for the service they had performed; but a forced march of twenty-five miles only, succeeded by one of thirty or thirty-five miles, was more than many of them were capable of performing, and was equal to the endurance of the best of them.

It was too evident after our loss that the hostile condition of the various Indian bands, in and about this Territory, was such that it was necessary to be fully informed of its extent and of their numbers before prosecuting further explorations. I therefore determined to go into winter quarters at once, that no time might be lost in submitting a report of the explorations to this point.

CHAPTER VIII.

General summary of the line explored for the Pacific railroad near the thirty-eighth parallel of north latitude, from Fort Leavenworth, Kansas, to the Sevier lake, Utah.

Character and fertility of the Plains: timber, grass, rain.—Approach to El Sangre de Cristo Pass of the Rocky mountains.—Soil, cultivation, grazing, and water.—Mountain valleys.—Valley of San Luis.—Coochetopa Pass and surrounding country.—Grand River valley lands.—Roan mountains, and the country between Grand and Green rivers.—From Green river to the Wahsatch mountains.—Summit of the Wahsatch mountains.—Valley of the Sevier river and Sevier lake: its sterility.—Ingredients in the soil injurious to vegetation over large spaces.—Aqueous depositions unfavorably distributed and very limited.—Capacity of the country to contribute to the support of a railroad.—Railroad stations and posts.—Permanent water on the line.—Great scarcity of timber on the line.—Coal, where found.—Building stone.—Railroad practicability of the line.—Elevations, grades, sections, passes.—San Luis valley.—Coochetopa Pass and tunnel.—Altitudes and grades.—Pass and Coochetopa creeks.—Grand river section.—Blue to Green river.—Miry soil.—Stone for sub-structure.—Grades and bridges.—Rocky district west of Green river.—Grades from Green river to Akanaquint spring, White river, Clever creek, San Rafael river, &c., to the Wahsatch Pass.—Wahsatch Pass and tunnel.—Salt Creek cañon, grades, and character.—Sevier River valley, and passage through the Un-kuk-oo-ap mountains to Sevier Lake valley.—Further surveys, and existence of other lines near this.—Duties performed by scientific gentlemen of the party.—Climate.—Indian hostilities in Utah.—Further surveys will be made.

The general character of the country traversed and explored, briefly recapitulated, is as follows:

For six hundred miles west of the western line of the State of Missouri the country is a rolling prairie, gradually rising towards the Rocky mountains. For two hundred miles it is very closely assimilated to the soil and character of that State. West of that point it gradually changes its character, becomes more arid and sandy, and much less fertile; and at a point between Walnut creek and Pawnee fork it has entirely changed. Timber almost entirely disappears—it is very scarce east of this—and the short, curly buffalo-grass takes the place of the coarse tall grass of the east; the soil is hard and dry clay intermixed with sand, with a surface sheet of an inch or two in thickness, intermixed with vegetable mould. Rain falls but seldom, and the cool mountain wind sweeps down at night, affording in summer an agreeable relief from the shadeless heat of the day. The country preserves this character west to the Cimmaron crossing of the Arkansas river. Beyond this the variety of artemisia known as sage, first begins to appear in quantity; and grass and water, away from the main water-courses, become scarce. In July, or early in August, the buffalo-grass of the Plains becomes entirely dry, although it is still very nutritious, and is fine grazing for buffalo and sheep; but in this short, curly form, this grass is not large enough for draught cattle. They will subsist on it for some time, but invariably fall away when marching and feeding on it. West of the Big Timbers of the Arkansas river, it becomes an important inquiry early in the day, at what point grass can be found for a camp; and the march must be lengthened or shortened to suit the locality of this important plant, which is found alone on the narrow river bottom, the hills being very dry and barren. Leaving the Arkansas river for El Sangre de Cristo Pass of the Sierra Blanca—the eastern range of the Rocky mountains—the country becomes more broken and rises more rapidly; its soil is very light, formed from sandstone, shales and slate; but it is much more abundantly supplied with grass than the preceding hundred miles of the Arkansas bottom, and of a superior quality, but it is still scattered and thin. And no part of the surrounding country will compare favorably with the inhabited parts of any of the States. It is alone suited for grazing ranges—not farms, unless they are so extensive as to embrace several miles. It is true, the cultivation of grains and of roots, to some extent, on the narrow borders of the streams where water can be com-

manded, will reward the efforts of labor; but the amount of water is so small that it never can supply more than the limited wants of a sparse pastoral population. Entering the mountains, the small valleys and parks abound in the most luxuriant grass, furnishing abundant pasturage for a given amount of stock; but these fields are very limited in extent, and generally too cold for cultivation. Rains are, however, not wanting in these lovely mountain retreats. The extensive valley of San Luis, lying between the Sierra Blanca on the east and the Sierra San Juan on the west, and watered by the Rio Grande del Norte and its numerous small tributaries, is in general one vast sage plain from the Rio Colorado to Gunnison's Pass. The grass on the lower tributaries of the Rio del Norte, in this valley, is very limited indeed; it is more abundant on the upper affluents, where a few fields of prairie grass, a mile or two in width, were observed, and the authority of our guide given for extensive grass prairies on the Rio del Norte itself. But all these grass fields, with the greatest amount of cultivation which can be supplied with water from the fine little streams of this valley, can, under the most favorable circumstances, only support a meagre population. The margins of the mountain streams about the Coochetopa Pass furnish some fine grass, which extends down to Grand river; but the hills on either side of this route are barren and naked, and no land can be found among them capable of sustaining even small settlements other than for grazing purposes.

The immense valley depression, from thirty to fifty miles in width, between the Elk mountains and the Sierra de la Plata, filled with rocky and broken hills, mesas and connecting mountain ranges, through which Grand river flows in cañones, is almost destitute of land which can be cultivated. The hills are often densely covered with sage; and some of the most luxuriant and extensive fields of grass seen on the route were traversed among these hills and tables. The small spaces of bottom land on Grand river, at the junction of the Coochetopa and at Roubideau's old fort, are the only ones on that stream, in the long distance which we followed it, which can be called bottom lands; and these are not only very small for settlements, but are frequently, if not annually, overflowed.

The Roan or Book mountains fill a large space between Grand and Green rivers, and leave to the south of them only an arid, sterile, pulverulent waste, with bunch-grass enough on the hills for passing droves and herds of stock. And from Green river to the Wahsatch mountains, the miserable soil maintains the same ash-heap friability. The country is very rocky sandstone, broken, upheaved, and intersected in every direction by ravines, chasms, and beds of creeks. A little bunch-grass is scattered over the hills, but they are generally barren or covered, as on the margins of the streams, with sage. Such, also, is the character of the country from the foot of Book mountains to the Sierra Abajo, near the junction of Grand and Green rivers. This section is, therefore, not only crossed with great labor and difficulty, but is entirely valueless for the wants of civilized man. The summit of the Wahsatch mountains is a finely-grassed region, but entirely unfit for cultivation. The extensive valleys of the upper Sevier river and of the Sevier lake, divided by the Un-kuk-oo-ap mountains, are vast artemisia plains, with a dry, friable, or sandy soil, quite uninhabitable, except on the grassy bases of the mountains, where an occasional mountain stream affords a limited supply of water for irrigation.

In these plains, as in all those west from the vicinity of Bent's Fort, on the Arkansas, to the Basin, and in a few instances in the mountains also, the soil is more or less impregnated with alkali, which is very destructive to vegetation; and salt is often seen effloresceing upon the surface. And as the amount which is annually carried off by lixiviation and drainage—from the very limited amounts of rain and snow which are precipitated upon this extensive district in proportion to its area, and the very great inequality in their distribution over it, for the great body of the rain and snow annually falls upon the higher peaks and ranges, and is carried down to the main streams through deep cañones and chasms, leaving the plains parched and dry—is constantly renewed from the decomposition of sedimentary rocks, it is impossible to anticipate the period when the supply will be exhausted; and if the progress of science should develop the means of

neutralizing its injurious effects, a material change of climate, providing a greatly increased amount of aqueous vapor, would be requisite to bring any considerable extent of this arid territory under cultivation. It is not too much, therefore, to say, that, unless this interior country possesses undiscovered mineral wealth of great value, it can contribute but the merest trifle towards the maintenance of a railroad through it, after it shall have been constructed. But for the support of small posts and stations, at suitable intervals for protecting and operating a railroad, there are sufficient lands on this line capable of cultivation at points already indicated.

The positive evidence existing with regard to the depth of snow which annually falls upon this line, is very limited. The number of small parties, however, which annually cross the Plains during the winter months, transacting business, and carrying the mails to and from New Mexico and Utah, would seem to leave no doubt as to the practicability of crossing them successfully in winter by railroad. Our guide in the Sangre de Cristo Pass crossed it in February, 1853, a winter of great severity, and more than usual fall of snow. He represents it to have been, at that time, ten feet deep in the small ravines of the pass, while the ridges were nearly bare; and that he was occupied seven or eight days in making the crossing, which, in summer, is easily made in two. Mounted troops, in pursuit of Indians, have occasionally crossed this pass in midwinter and early spring; but this is a hazardous undertaking. During the winter of 1852–'53, the snow at Fort Massachusetts, which is situated in a sheltered valley under the Sierra Blanca, about seventeen miles from the summit of this pass, is represented, by the army officers stationed there, to have been very dry, and about two feet deep. The vegetation and timber in the passes upon this line, offer no discoverable snow marks in summer, indicating its winter depth. But from the information which I have gained from trappers and other persons, more or less familiar in winter with the country west from Fort Massachusetts, I have little doubt that the depths of snow in the valleys, generally, may be safely estimated not to exceed that of the Plains, as the mountains are approached from the east. And its depth in the Sangre de Cristo Pass, from its altitude and similar position, may undoubtedly be taken as a very near approximation to that of the other passes of the Sierra Blanca range, of the Coochetopa and Wahsatch passes, and of the entire cañon section of Grand river above the Uncompahgra, and it must to the same extent be regarded as formidable in these localities as in that pass. There is danger, however, of over-estimating the obstructions arising from snow in mountain passes, where its fall over the general surface of the country is not sufficiently great to offer a general obstruction to the operation of railroads. It is well known that in snowy countries, where roads are worked over rolling prairies, or among ordinary hills, small cuts are greatly more liable to obstruction from snow-drifts than deep cuts, (artificial passes,) the snow accumulating in, and filling up the former, while in the latter the drifts are deposited just below the crests of the excavations, or the cuts are kept clear of snow by the currents of wind which sweep through them. It is usual, therefore, to erect snow fences eight or ten feet high, a few feet without the crests of small cuts in such localities, to secure the tracks from snow. In mountain passes, therefore, if the same causes operate upon a large as well as upon a small scale, where the crests of the gorges are hundreds, and frequently thousands of feet above the passes through which powerful storms and currents of wind sweep, there would seem to be little danger of obstructions arising from drifts of snow only; and did not the passes themselves contain numerous small ravines in which drifts accumulate, it is perhaps doubtful whether they would not be even less obstructed by snow than the more open valleys. The statements of all the persons with whom I have conversed, who have had experience in the mountains of our great interior territories, under widely different localities and latitudes, confirm, or rather have suggested to me, this view of the action of the winds upon snows in mountain passes. They represent the main difficulty which they have encountered in passing them, to have been in crossing the small side or lateral ravines which extend high up the sides of the passes, and cannot be turned by their heads, and are obstructed below by other causes. The ridges and deep ravines extending into passes, are usually but slightly obstructed, depending, however, in this respect,

greatly upon their direction relative to the currents of wind sweeping through the passes. And it does not seem a serious objection to these statements, that the greatest amounts of snow in mountain districts are accumulated towards their summits, and on the lee-sides of peaks and ridges, and that the deep ravines and chasms, extending high up the mountain sides, along the faces of which heavy storms sweep, receive and retain vast amounts of snow, for in these ravines there can be no through-currents of wind. And it is important to state, for the proper understanding of this subject, that the enormous depths of snow which were encountered, both in the Rocky mountains and in the Sierra Nevada, leading to those terrible disasters with which the country is familiar, were not encountered in a position, in any instance known to me, deserving the name of a mountain pass, however alluring the approach to it may have been; but, on the contrary, they were encountered in attempts to cross high ranges at points more or less broken by chasms and ravines like those last referred to. If it be true, therefore, as our present information indicates, that the annual amount of snow, as well as of rain, falling in these interior mountain regions, is comparatively small, and not sufficient in its general depth to seriously obstruct the working of roads, its accumulation in mountain passes cannot be regarded as fatal to railroad lines which are otherwise available.

Permanent water is found—for we were upon the route during the dryest part of the year—at suitable intervals for the wants of a road, both in its construction and operation, at all points of the line explored, except between Grand and Green rivers, a distance of seventy miles, on which none except rain-water, which fell while we were passing it, was seen. A spring is said, however, to exist on the Spanish trail, east of the point where we first struck it between these rivers; but, as already stated, its position and size are unknown to me. But if it exists, it will be easily found; and much more extensive explorations of this section than have yet been made, will be required before the quantity of water upon it can be determined.

For one hundred and fifty miles west from the State of Missouri, timber is found in sufficient quantities for the construction of a road, to the junction of the Smoky Hill and Republican forks of the Kansas river, provided the entire amount suitable for its construction, now growing upon the water-courses, be applied to it, but not otherwise.

Settlers upon these lands will find the quantity of timber upon them too limited for their necessities; and in the construction of a railroad, therefore, subsequent to their occupation, the requisite amount of timber will no longer be found upon them. From the junction of these streams west to the foot of the Sangre de Cristo Pass, a distance of five hundred miles, no timber whatever exists that can be used in the superstructure of a railroad. In and about this pass, Captain Gunnison says, "spruce-pine in abundance is at hand to supply ties for hundreds of miles of railroad, especially if that which the great fire of 1851 swept over and left standing be not left to decay."

In ascending the valley of San Luis but little timber was seen in the mountains; and none exists in the valley which could be used in building roads. From Fort Massachusetts southward the mountains will, however, furnish an abundant supply of excellent pine. In the mountains about the Coochetopa Pass, one hundred miles from Fort Massachusetts, pine is the only timber, (the quaking asp being only suitable for fuel after it has been seasoned;) and it is generally small, but, it is believed, sufficient for the purposes contemplated. From the vicinity of this pass west to the Sevier lake, a distance of five hundred and fifty miles, scarcely a tree was seen, except a few low-branching cedars among the Rock hills west of Green river, which could be used in the construction of a railroad; but it is probable, *although very difficult of access*, that a limited supply can be drawn from high up on the heads of numerous streams, which enter Grand river from the mountains above, and for a short distance below, the junction of Blue river. And again, in the mountain between Green and White rivers, and in the Wahsatch mountains, in similar localities, it is probable that more or less timber can be obtained; but if sufficient in quantity, it will necessarily require to be transported to such distances as to make its expense enormous, which will render the substitution of stone necessary wherever it can be used. Coal is found at three points

upon the line: on the Wahkarrussi, an affluent of Kansas river; on Grand river, at Salt and Bitter creeks; and near our camp of the 11th of October, on Big Rock creek, at the eastern base of the Wahsatch mountains. That on the Wahkarrussi has been more or less used, and is doubtless abundant and good; and if the supply should not prove abundant upon working the other localities observed, the formation is such, at least on Grand river, as to render it highly probable that an inexhaustible supply of coal exists in the immediate vicinity.

The great scarcity and unequal distribution of timber upon this line renders the character of its rocks an important subject of inquiry. The great body of those underlying the Plains are sandstone, more or less argillaceous, the strength and durability of which in superstructures can only be estimated from their appearance, the soil formed from their disintegrations, and the apparent rapid decay of most of the ledges exposed to the weather, which indicate inferior stones. Captain Gunnison says that the barracks at Fort Riley are being built of the white limestone of the vicinity; and a superior quality of limestone is found on the Arkansas, below Bent's Fort, and various localities of it are indicated in Dr. Schiel's geological report, appended to my report of subsequent explorations.

A more minute and extensive examination of the Plains would probably discover the existence of limestone and other rocks in various localities; but as no heavy masonry will be required in carrying a road over the Plains, in the absence of other rocks those already known will be sufficient. At the Huerfano butte, where they exist in abundance for building purposes, the first granitic rocks were seen. Thence westward to Sevier lake, soft disintegrating sandstones underlie the plains, and form many of the lower mountain ranges and hills, but the higher ranges of mountains will furnish superior qualities of stones for railroad structures. On Grand river, granite forms the head of the first cañon, overlaid by sandstone, with a thin stratum of igneous rock capping the high tables. Granite is also found in the Sangre de Cristo Pass and at Sahwatch butte. In the Sangre de Cristo Pass, the gray rocks have a crystalline porphyritic structure; in the approach to the Coochetopa Pass, they are red and more vesicular; and in the Wahsatch Pass, approach the basaltic character.

From the vicinity of the mouth of the Kansas river to the foot of El Sangre de Cristo Pass, in the eastern range of the Rocky mountains, the features of the country are very favorable for the construction of a railroad. By the line we followed, it is generally an open rolling prairie to where we crossed the Arkansas river, with a very gradual but uniformly increasing elevation to the west. West from the mouth of the Apishpa, on the north side of the Arkansas, the prairie hills begin to rise abruptly, and extend closer in to the river; but on the south side rise more gradually, sweeping up in gentle swells to the divide between the small ravines which descend to the Apishpa on the south, and the Arkansas and Huerfano rivers on the north. Preserving the elevation thus gained, the line is easily extended west to the Cuchara and Huerfano rivers above their cañones; entering the valley of the latter stream a few miles below its butte, and ascending it to our camp of August 9th, which may be regarded as the foot of the Sangre de Cristo Pass, whose summit is, by our trail, fourteen miles above this point. In constructing a railroad across the Plains to the foot of this pass, the only obstacle to be overcome not encountered by similar constructions in all open, rolling prairie countries, is in the gradual western ascent from the Mississippi river to the foot of the Rocky mountains; and this ascent, as has been already stated, by ascending the main water-courses, (the Kansas and Arkansas rivers and their tributaries,) is very gradual, increasing with a general uniformity as we approach the mountains.

The elevation of our camp near Westport, on the western border of the State of Missouri, was 990 feet above the Gulf of Mexico, and 615 above low-water mark at St. Louis. On Pawnee fork, an affluent of the Arkansas, 293 miles by the Santa Fé road, and 322 miles by the Smoky Hill route, from that camp, our elevation was 1,962 feet above the Gulf; giving an average ascent per mile (independent of the ordinary inequalities of the ground, which were noted from day to day) of three feet three inches, and three feet, respectively. By the path which we followed,

it is 68 miles from this point to our camp of July 16th, above Fort Atkinson; and the ascent 418 feet, or six feet two inches to the mile. But if the river be followed between these points, the distance will be increased and the ascent correspondingly diminished; or, by taking a more direct course, the distance would be lessened, slightly increasing the grade, which will be best seen by a reference to the section of this part of our route. For eighty-nine miles west from this camp, following the banks of the river, we ascended five feet four inches to the mile; and in the succeeding 105 miles, to a short distance below Bent's Fort, the average ascent per mile was seven and three-fourths feet; and twenty feet seven inches per mile for the next thirty-four miles to the mouth of the Apishpa. The general section which accompanies this report, from this point to the Huerfano butte, is that of the line followed by our wagons, and the distance, eighty miles, given on it, exceeds by one-fourth the length of the line necessary for the construction of a railroad between these points. The general ascent to be gained by the shorter line, is twenty-eight feet ten inches to the mile. The natural grade for fourteen and a half miles above this point, following the river, is fifty-two feet ten inches per mile, which brings us slightly within the eastern spurs of the Rocky mountains.

The summit (so to speak) of the great interior trunk of the continent, upon which nearly all its mountain ranges, masses, and peaks are elevated, is reached, upon this line, at the Huerfano butte, which is 6,099 feet above the sea, and 5,109 feet (nearly a mile) above our camp near Westport; and the whole of this remarkable ascent—which has its counterpart, more or less approaching the same elevation, by whatever line the mountains are approached from the east—is gained by the easy grades given, over a continuous plain, without once passing a remarkable hill or making at any point a considerable descent.

The estimated distance from our camp, of August 9th, on the Huerfano river, by the circuit indicated for a railroad, ascending the stream through the large amphitheatre drained by the river and its branches, to the Black butte, (twelve miles,) to Williams' Pass fork, (two miles,) and Gunnison's creek, (three miles,) and thence ascending the latter stream to the summit of El Sangre de Cristo Pass, is from twenty-four to twenty-six miles, and the difference of elevation 2,354 feet—an average of ninety-eight feet and one inch to the mile for the shorter, and ninety feet six inches for the longer distance. The altitude of the summit of this pass is 9,219 feet above the sea; and of the highest point passed by our wagons, 9,358 feet; the altitude of the lowest and nearest peak to the pass being 9,852 feet. Captain Gunnison says, "a single grade can easily be carried from the summit of this pass to the gorge of the Huerfano river, (just below our camp of August 9th), but two—one along Gunnison's creek, and one on the river—would probably be preferable." The Sangre de Cristo creek rises near the summit of the pass, and descends in a general southwestern direction, through a narrow ravine, for 7.09 miles, which thence gradually opens for six miles towards the valley of San Luis. The mountains on either side rise several hundred feet above the stream. The descent of the stream from the summit of the pass, is 101 feet per mile for the first mile and three-fourths, and 103 feet per mile for the succeeding mile and thirty-four hundredths. Six miles below this point we left the creek, and rose to a plain extending along the base of the mountain spurs, which we followed for 4.57 miles, to Utah creek, near Fort Massachusetts, having descended twelve feet to the mile for the entire distance, 10.57 miles. By descending from the summit of the pass along the side of the mountain on the right of the creek, a road can be constructed, throwing a larger proportion of the descent upon the lower part, where it should be carried on a mass of low hills to the plain indicated above, which subsides gently into the valley of the Rio Grande del Norte.

The broad open valley of San Luis, enclosed on the east by the mountains just crossed, and on the west by the chain of the Sierra San Juan, and drained by the Rio Grande del Norte and its tributaries, is so level that a railroad can be carried over it in any desired direction. From Utah creek we descended 49 feet per mile for 10.93 miles, to White Mountain spring; and 14 feet per mile for the following 13.46 miles, to near Roubideau's Pass. This pass was

examined and deemed entirely impracticable for a railroad; the grade to the west being, for the first 1.25 mile, at the foot of the ravine, 298 feet to the mile, and 490 feet to the mile for the succeeding seven-tenths of a mile, and 554 feet per mile for the last three-fourths of a mile at the summit, with a broad slope extending thence north and east to the Huerfano river.

Continuing up the valley of San Luis, the grades from camp to camp are, respectively, as follows: An ascent of nine feet eight inches for 9.78 miles; a descent of 24 feet per mile for 9.06 miles; an ascent of 8.7 feet per mile for 11.72 miles; a descent of 9.5 feet for 5.96 miles, with an ascent of but 19 feet in 15.20 miles, to the camp on Sahwatch creek at its entrance into the valley of San Luis.

Gunnison's Pass lies immediately to the northwest of the Sierra Mojada, between the headwaters of the Rio Grande del Norte, in this direction, and the Puncha creek, an affluent of the Arkansas above its cañon. Captain Gunnison deemed it practicable for a railroad which should ascend the Arkansas river through its cañon, and across the plains which lie above it, ascending a branch of the Puncha creek to the summit of the pass, and descending through Homans' park to the valley of San Luis. The altitude of this pass, 8,603 feet, and the grades in its vicinity, are derived from aneroid observations, referred to our camp of August 27th, 28th, and 29th, in the San Luis valley; but are not relied upon with great confidence for actual altitudes above the sea, although the relative differences of level indicated by them are more satisfactory. They give grades of 185.5 feet per mile for four miles, ascending the pass from the east; then 228 feet per mile for one mile and a half, followed by a grade of 113 feet to the mile for three-fourths of a mile, to the summit. Descending to the west, the difference of level is 56 feet per mile for six miles; then 68 feet to the mile for three miles, to the centre of Homans' park, from which a road can be carried in any direction across the San Luis valley.

The approach to the Coochetopa Pass, by the Sahwatch creek, opens very favorably for the construction of a railroad. The mouth of the valley of this stream is from five to seven miles in width, but soon narrows in ascending it to a few hundred yards, and seldom again exceeds half a mile in width to its head. For twelve miles we ascended slightly over 39 feet to the mile; and for the following fifteen miles nearly 61 feet to the mile—having, during the day, left the Sahwatch creek and ascended its branches, occasionally overhung by walls of igneous rocks, giving this part of the pass a defile character. But, in the construction of a railroad, it will be necessary to carry it on the side of the ravine considerably above the stream, gaining an elevation of at least 200 feet at the fifteen-mile station referred to; which, from the formation of the hills, must be done upon the last few miles below that point, the elevation of which is 8,960 feet above the sea, while the summit of the pass, 3.83 miles distant, is 10,032 feet, which will require for its passage a grade of 124 feet per mile for 3.07 miles above this point, followed by a tunnel, entering the mountain from the east three-fourths of a mile below the summit, diminishing the elevation to be overcome by 490 feet, and terminating to the west, with a deep approach, (near our camp of September 2d), 1.33 mile below the summit—the length of the tunnel, which must be cut entirely in rock, including the approach, being two miles.

The altitude above the sea, ten thousand feet, indicated by our barometers in this pass, is that to which all the depressions in the vicinity will approximate. It is possible, however, that the summit of the Carnero Pass, just south of the Coochetopa, may be more easily passed by a railroad than the latter; but this can only be determined by a minute survey. In any future exploration, examination should be made for a passage in these mountains by ascending any small stream entering Homans' park from the northwest, and passing over to the head of the Coochetopa creek, and thence descending to Grand river—the formation of the country indicating a pass in that direction.

Below our station, 1.33 mile west of the summit of the Coochetopa Pass, the grade again becomes practicable, being, by the valley of Pass creek for 2.24 miles, 108 feet to the mile; 68 feet to the mile for the next 2.15 miles; 93 feet per mile for the following 2.05 miles;

and 42 feet per mile for the succeeding 3.47 miles. In this descent much cutting and filling will be necessary, the hills on each side of the creek being cut by small ravines deep back towards their summits. Pass creek enters a broken cañon at this point, which extends to its junction with the Coochetopa, sixteen miles below. Lateral cañones enter the main one at several points, but principally from the left, and broken hills rise somewhat above the general level of the descending plain; "but a railroad can be carried over them by rising below for some distance." The descent of the stream in the sixteen miles, is 71 feet per mile. Seven miles below this point the Coochetopa creek enters Grand river in a bottom, eight or nine miles in length by from one-half to one mile and a quarter wide, which is frequently overflowed. From this point until we reached the Uncompahgra river, our route followed a very rough and broken country, for the description of which reference should be made to the accompanying section, daily journal, and map, from September 6th to September 20th, as it is by far the most difficult and expensive section upon the route for the construction of a road.

From the crossing of the Nahunkahrea or Blue to Green river, the greatest difficulty to be overcome in the construction of a road will be to secure a firm bed for it to rest upon; the friable, ash-heap character of the soil being such that, in wet weather, for many miles at a time over the whole surface, it forms miry beds of a brick-clay consistency, in which animals sink half-leg deep in crossing. Fortunately an inexhaustible supply of stone is at hand at various points along the route, for the construction of a suitable foundation. The heaviest grade upon this section, from camp to camp, is an ascent of 71 feet per mile, on the 27th of September, for 5.66 miles; the other grades varying from 2 to 13 feet per mile between these rivers, a distance of 100 miles from the junction of Grand and Blue rivers. Numerous bridges and culverts will be necessary on this section.

The rocky district west of Green river is of the same ravine and chasm-like character (but upon a much smaller scale) with the section on Grand river; but the soft sandstone is here easily cut, and the water-courses more easily passed, the streams not being so torrent-like. But the number of bridges which will be required will be so large that great expense will attend the construction of a railroad on this part of the line explored. The grades upon it are heavy and very variable, besides the ordinary inequalities of hills and ravines. They are from day to day as follows, on the line traversed, and by the shorter one indicated in the journal, will not differ materially:

From Green river to Akanaquint spring, 16.76 miles, ascent 35 feet per mile; and for the succeeding 4.6 miles, 119 feet per mile; and for the next 1.14 mile, 165.7 feet to the mile, to where we left the Spanish trail; but this distance can be increased, bringing the grade down to, perhaps, 100 feet to the mile. Continuing from this point for 6.08 miles upon the summit-level between Green and White rivers, we next descended, for 3.96 miles, 111.3 feet per mile, and 16.41 feet per mile for 9.82 miles, to camp on White river.

Ascent to Clever creek, 8.72 miles, 41.85 feet per mile; for the succeeding 11.11 miles, returning to White river, ascent 23 feet per mile; and 38 feet per mile for 13.26 miles, with a descent of 22 feet to the mile for the succeeding 13.17 miles. For the next 11.40 miles we ascended 25.61 feet per mile, and 17.6 feet per mile for the next 13.46 miles; and for the succeeding 15.65 miles, the ascent was 53.16 feet to the mile to the foot of the Wahsatch Pass.

This pass is entered by crossing a small ridge between our camp of October 12th and Akanaquint creek, and ascending that stream through a narrow defile, from 100 to 200 yards in width for some distance, and then leaving it by a ravine which rises between open grassy hills to the summit of the pass; the descent to the west being of the same character.

For the passage of this mountain by a railroad, it will be necessary to approach it from the east by a heavy grade of 125 feet to the mile, after reaching the Akanaquint creek, to within one-third of a mile of the summit, where a tunnel with deep approaches will be required—the whole in rock, but not exceeding three-fourths of a mile in length—diminishing the elevation to

be overcome by from 175 to 200 feet, and giving a grade of 131 feet per mile for 3.6 miles west of the summit, and thence to the vicinity of our camp of September 13, or even less than this, by keeping on the side of the ravine above Salt creek. Altitude of the pass, 7,820 feet.

Two miles from this point, towards the valley of the Sevier river, Salt creek, (by following which a railroad can alone be carried), enters a rocky cañon, more or less broken by lateral streams, which it follows for sixteen miles. "Through this cañon a railroad may be carried, but, owing to rock cutting, only at a very heavy expense." The altitude of our camp, two miles above its head, on Salt creek, was 6,976 feet, to which seventy-five feet must be added, to connect with the estimated grade for a road at that point, which will give a descent of ninety-five feet per mile for the eighteen miles intervening between that point and the foot of the cañon, 1,706 feet below it. For 2.65 miles below the cañon, to the foot of the mountains, we descended 91 feet per mile; and from the foot of the mountain to our first camp on the Sevier river, 3.13 miles, the descent was 27 feet to the mile.

No other than the most ordinary obstructions exist to the construction of a railroad from this camp to the most western point of our explorations, near the Sevier lake. It should follow the river, passing with it through its gorge in the Un-kuk-oo-ap mountains; and thence take its course to the west. The average fall of the river for thirty-one miles, upon which observations were taken for three days, is but four feet to the mile; and it continues this easy descent to the lake.

For crossing the four main streams upon this line, heavy and expensive bridges will be required; especially those over Grand, Blue, and Green rivers, whose currents are very powerful and rapid, and annually subject to enormous freshets—the Arkansas being, comparatively, a gentle stream. And, besides these, after approaching Grand river, the ordinary side ravines and cañones requiring bridges are very numerous, while the passage of each of the more formidable ones can only be accomplished by great labor and at an enormous expense, to say nothing of their aggregate cost.

If more minute surveys shall at any time be made upon this general line, alterations and improvements will doubtless be made in it to some extent, but its general character cannot be improved. A pass may be found, as suggested, at the head of the Coochetopa creek, in the Sierra San Juan, which may be superior to the Coochetopa Pass itself, and a more direct line from Green river to the Wahsatch Pass be secured, by following the Spanish trail across the Rock Hills, or even by ascending the San Rafael river, but, if found more favorable or direct, will not alter the general character of the route; for the line followed is not only the best that could be discovered in the vicinity, but was pointed out to us, as such, by the most reliable and experienced guides we could obtain, and who had recommended the route as very superior, and may reasonably be supposed to have done all they could to establish the correctness of their judgment, and by the Indians who inhabit the country, and are as familiar with every fastness and mountain pass in it as with the use of the arms with which they procure their daily subsistence.

And after the most careful observation and study I have been able to bestow upon the various chains of mountains and water-courses upon the route, seen at least during parts of every day, in the clear atmosphere of the elevated mountain regions, with a distinctness of outline and clearness of detail at distances difficult to be realized by persons who are only familiar with the extent, beauty, and grandeur of landscape views in the comparatively moist and clouded atmosphere of the more civilized portions of our country, I hazard nothing in saying that no other line exists, in the immediate vicinity of this, worthy of any attention in connexion with the construction of a railroad from the Mississippi river to the Great Basin.

For the geographical positions (latitudes) laid down from astronomical observations in this report and accompanying map, I am entirely indebted to my accomplished assistant, Mr. S. Homans, astronomer for the expedition, by whom the observations were taken and the computations made. Our entire failure to obtain suitable observations for longitudes, is explained in

the report accompanying the table of latitudes. The longitudes used in the construction of the accompanying map, are derived from a comparison of those given by Nicollet and Frémont for St. Louis, and the public surveys carried westward from that place to the western boundary of Missouri, and thence to Fort Riley, in determining the boundaries to Indian lands; and of Frémont and Emory at Bent's Fort; and Frémont at Great Salt lake.

I am also indebted to Mr. Homans for the construction of a map of the route, which he made from the topographical sketches taken by our late comrade, Mr. Kern, and from those taken by himself subsequent to the barbarous massacre of that gentleman; but the more elaborate map, which accompanies the report, has been made from the same notes and from that map by Mr. F. W. Egloffstein, my very able assistant in the topographical department of the explorations prosecuted during the year 1854.

Want of time in which to prepare the geological report of this line, to be submitted with this report, compels me, reluctantly, to defer it until the completion of my report upon the explorations of the present year.

Respectable collections in botany and natural history were made during the exploration; but, owing to the unfortunate death of Mr. Creutzfeldt, the description of them has been necessarily delayed, but will accompany the report referred to above.

The meteorological tables and tables of distances were kept by my young assistant, Mr. James A. Snyder.

Until within a few days, I had intended to resume the explorations required by your instructions, immediately after completing and forwarding this report, by proceeding through the Timpanogos cañon to the Kamas prairie, and thence east as far as Bear river; and, in returning, have descended the Weber river to this valley, which, if practicable, would greatly facilitate our spring operations. But, unfortunately, the winter has within the last two weeks become unprecedentedly cold, the thermometer falling to 10°, 15°, and 20° below zero; while the depth of snow in the valley is considerable, and greater in the mountains, forbidding our ascending them until the winter moderates.

Indian hostilities still continue; but few depredations have, however, been committed on the inhabitants of the territory within the last two months, and hopes are entertained by the civil authorities of effecting a peace, which, if it could be maintained, would promote the prosperity of new settlements.

We shall make the examination above referred to, as soon as the winter will permit our animals to subsist in the mountains.

I am, sir, most respectfully, your obedient servant,

E. G. BECKWITH,
First Lieutenant 3d Artillery.

GREAT SALT LAKE CITY, U. T.,
January 31, 1854.

CHAPTER IX.

Discussion of Barometric Observations, and Tables of Altitudes and Distances, of the line explored from Westport, Mo., to Great Salt Lake City, Utah Territory; also Tables of Simultaneous Observations in, and Data for Profiles of, the mountain passes of the line. 1853.

I.—Introduction to, and corrections applied in, barometric computations.—Table for horary corrections of observations.—Corrections for extreme air temperatures.—Comparison of field barometers with Dr. Engelmann's barometer at St. Louis, Missouri, both before and subsequent to the surveys.—Table of monthly mean observations at St. Louis, by Dr. Engelmann.

II.—Barometric and meteorological observations, and table of altitudes and distances, for the profile of the line of survey from Westport to Great Salt Lake City.

III.—Data for profile of Roubideau's Pass.

IV.—Simultaneous meteorological observations at Coochetopa Pass.

V.—Observations for a tunnel or deep cut in the Coochetopa Pass, allowing fifty yards as the width of the ridge at top.

IV.—Table IV resumed.

VI.—Data for the profile of the Coochetopa Pass, and declivities near its summit.

VII.—Simultaneous meteorological observations at the pass and on the route followed across the Wahsatch range.

VIII.—Data for the profile of the route followed across the Wahsatch mountains.

I.—*Introduction to, and corrections applied in, barometric computations.—Table for horary corrections of observations.—Corrections for extreme air temperatures.—Comparison of field barometers with Dr. Engelmann's barometer at St. Louis, Mo., both before and subsequent to the surveys.—Table of monthly mean observations at St. Louis, by Dr. Engelmann.*

The Bunten barometers (Nos. 496 and 551) are exclusively relied upon for the determinatio of altitudes of the entire line. The readings of the aneroid barometers exhibit variable errors; and as the mercurial barometers retain their reliable and uniform character throughout, no necessity exists for the use of the aneroids, the records of which are, therefore, not given.

The zero errors found by Doctor Engelmann, in his comparison at St. Louis, to apply to the Bunten barometers before the commencement of the work, did not remain as between the two instruments, even at the first considerable camps of the survey. They were, therefore, rejected in all the computations, and no zero error was at any time applied. For mean readings the two barometers usually agreed very nearly—the difference between them being that No. 496 was too slow in its movement when considerable changes of altitude occurred, and required correction or the substitution of the other in such cases.

For mean readings at stations where several observations were taken, the results of both are believed to be a very near approximation to standard accuracy, and the instruments appear to have been but slightly deranged at the termination of the survey. The zero errors found in them by Doctor Engelmann, on their return, were obviously introduced after the close of the work, and do not require to be applied to it.

In the discussion of the observations, the readings were first corrected for temperature to the height of the mercurial column at 32° Fahrenheit. A minor error of non-adaptation of the common formula, to the temperature expansion determined by Shumacher for barometers of this construction, is thus avoided, and the greater advantage gained of combining all the observations at a station in a correct mean reading, to be used in a single computation of the altitude.

The mean of the observed air temperatures is used in these cases also, as avoiding, to some extent, a source of error in extremes of surface temperature; for which, in single observations, a table of corrections is appended.

All the observations were also corrected for *horary variation* of atmospheric pressure through the day, thus bringing each to the true mean position for the day.

The accompanying scale of horary corrections gives the values employed for each hour. They are derived primarily from well-determined curves of daily variation of pressure for the eastern United States, but with material and important modifications and additions established by the observations of other surveys in the interior of the continent, principally by that of Lieutenant Whipple. By the observations through the winter months at Great Salt Lake City, the measures of this horary scale are shown to be less for that season, and to conform then more nearly than in summer to those observed in the eastern United States and in Europe. For the months occupied in the field-work of this survey, however, and for the districts traversed, the measure of the correction here employed is fully confirmed. At the sea-level, or so near it, as both extremities of the line are, the measures of horary variation again fall off to those belonging to well-known districts; yet, as no determinations of importance occur at these extremities, it is not necessary to give the scale belonging to them.

A correction previously found to be required for extremes of air temperature has been so well determined by the comparison of survey by levels, and with the barometer at the passes of the Sierra Nevada, surveyed by Lieutenant Williamson, that a scale of corrections sufficiently precise for practical use has been constructed. Where the error from this cause could not be eliminated by the use of mean temperatures, this scale has been employed in the determinations here made. The measures given for this correction belong to extremely arid climates, and to elevated districts, requiring modification in the position of the point where no correction is required; also in different seasons. As it affects great elevations in these arid districts by an extreme amount of at least 150 feet, it is too important to be neglected, notwithstanding a discretionary use of the [illegible] is usually necessary.

The reduced observations at stations on the Plains, from Pawnee fork to camp 33, (the first camp after crossing the Arkansas river), were referred to the mean barometric reading noted by Dr. Engelmann at St. Louis for July, 1853—the month in which they were made. The altitude of his station above the Gulf of Mexico, as determined by him from a long series of observations, was added to make up the entire altitude. For these stations and dates, the results thus obtained are very nearly identical with those computed by direct reference to the barometric mean at the level of the sea for the latitude.

For altitudes beyond this point direct comparisons of each camp are made to an assumed mean barometric reading at the level of the sea, in this latitude, of 30,000 inches—the barometer corrected to 32° Fahrenheit, and a mean air temperature taken of 57°. The constant belonging to the latitude and climate of the Gulf is 30.050 inches of the barometer, and 64° of air temperature, which would add unduly to the altitudes. The principle is assumed that the constants of pressure and temperature employed belong to the latitude, and that the resulting determinations of elevation belong correctly and alike to both the Gulf and the Atlantic and the Pacific. There are no well-determined mean readings of the barometer on the Pacific coast, yet the most of those recently made in California give the impression that a slightly greater mean atmospheric pressure exists there than in the same latitudes of the Atlantic. The constant has not, however, been altered for any portion of this line.

The discussion of observations at the principal passes has been in part upon simultaneous observations at an hour's interval in time and distance. The slower movement of one barometer, however, rendered it necessary in many cases to take successive readings of the best one, corrected for horary variation, for determinations of successive differences. The termini of these lines of ascent and descent were also checked by comparison of preferred results, as of the

mean of several at the summit, or elsewhere, with the nearer camps. The coincidence of results, by single and by successive steps, has been so satisfactory as to warrant the conclusion that the grades and altitudes of these passes are quite accurately determined. The correct use of such data, in the joining of intermediate with main lines, and in the correspondence of single observations with the means of observation, is the severest test of barometric survey; and discrepancies cannot be wholly removed.

The principal cause of these discrepancies is in the non-periodic variation of atmospheric pressure, for which no constant or correction can be given except by reference to continued readings for a month or more at some station near. Mean results best eliminate this error, and they are therefore preferred in the order of their number, or of the number of days they cover. In the ascent of the Arkansas, the uniform grade of the stream permits the use of four or five successive camps as a mean result, and two or three non-periodic variations are thus eliminated. Subsequently, to Great Salt lake, a less error from this cause is likely to occur, as this variation is least in August and September.

The observations generally sustain the checking and criticism which rank the results as a determinate survey, with a near approximation to absolute accuracy, and, as among themselves, sufficiently conclusive of grades and points of comparison.

Horary corrections of barometer.

Hour.	Inches.	Hour.	Inches.
6 a. m.	+.007	3 p. m.	—.030
7 a. m.	+.020	4 p. m.	—.045
8 a. m.	+.030	5 p. m.	—.050
9 a. m.	+.040	6 p. m.	—.030
10 a. m.	+.050	7 p. m.	—.020
11 a. m.	+.055	8 p. m.	—.005
12 m.	+.025	9 p. m.	—.000
1 p. m.	+.005	10 p. m.	+.010
2 p. m.	—.015	11 p. m.	+.020

Scale of corrections for extreme air temperatures.

Low temperatures.	High temperatures.
At 35° add 25°	At 95° subtract 15°
At 40° add 23°	At 93° subtract 13°
At 45° add 21°	At 90° subtract 11°
At 47° add 20°	At 88° subtract 10°
At 50° add 18°	At 85° subtract 8°
At 53° add 15°	At 83° subtract 7°
At 55° add 13	At 80° subtract 5°
At 57° add 10°	At 78° subtract 3°
At 60° add 5°	At 75° subtract 2° (See note.)

NOTE.—The measures of this correction are variable, to some extent, with the season, and apply nearly to departures from the mean of the month in which observations are made. It is here given as required for summer months, in which most of the observations in field surveys have been taken.

Captain Gunnison's barometers compared with the standard barometer of Dr. G. Engelmann, St. Louis, June 4 to 9, 1853.

Ten observations were made—

Range of standard barometer in that period, from 29.″505 to 29.″748, range 0.″243.

Mean differences of standard and compared barometers.

Bunten, No. 551=E+0.″006. Bunten, No. 496=E+0.″080.
Aneroid, No. 9889=E−0.″015. Aneroid, No. 9293=E−0.″025.

Extreme differences of range of standard and compared barometers.

Bunten, No. 551=E−0.″021 } =0.″048, difference of range.
Bunten, No. 551=E+0.″027 }

Bunten, No. 496=E+0.″046 } =0.″063, difference of range.
Bunten, No. 496=E+0.″109 }

Aneroid, No. 9889=E−0.″055 } =0.″090, difference of range.
Aneroid, No. 9889=E+0.″035 }

Aneroid, No. 9293=E−0.″005 } =0.″040, difference of range.
Aneroid, No. 9293=E−0.″045 }

E. represents Engelmann's standard barometer.

Both of Bunten's barometers are very slow in their movements. B. 551 gives a very dull sound when the tube is reversed, indicating air in the tube; 496 gives a clearer sound, and is probably free of air.

The station of Dr. Engelmann's barometer is above low-water mark of the Mississippi 106.5 feet, and above the Gulf of Mexico 482 feet.

Barometer Engelmann was, in June, 1853, equal to—

Bunten, No. 551−0.″006
Bunten, No. 496−0.″080

The Aneroids were both set to correspond exactly with barometer E.

After the voyage to California and back, barometer Engelmann was found, in September, 1854, equal to—

Bunten, No. 551−0.″072
Bunten, No. 496+0.″116
Aneroid, No. 7889−0.″448
Aneroid, No. 9293+0.″263

Therefore, as barometer E. has remained unaltered—

Barometer Bunten, 551, is now higher by 0.″066 than 14 months ago.
" 496, is now lower by 0.″196 " "
Aneroid, 7889, is now higher by 0.″448 " "
" 9293, is now lower by 0.″263 " "

Bunten, 551, is by far the best instrument of the whole set; but both barometers have the inside of the tubes at the lower as well as the upper levels so much soiled and darkened by oxydized mercury, that at a certain elevation of the barometer, at least, the reading off becomes very difficult if not impossible.

The aneroids are certainly very unreliable; but within the limited range of my observations, (between twenty-nine and thirty inches,) they performed well and corresponded pretty accurately with the fluctuations of my own barometer.

In calculating elevations from barometrical data, it seems best not to compare isolated observations made on the same day, or at the same hour, but to refer the observations made in the field (or the mean of several if they can be had) to the monthly means of the stationary barometer. I add, therefore, my monthly means for the last fourteen months. But the observations made west of the Rocky mountains cannot be referred to my barometer at all.

It is hardly necessary to add—what everybody who is in the habit of observing the barometer knows—that observations made in the forenoon, principally from 8 to 10 o'clock a. m., are generally higher, and those in the afternoon, principally between 2 and 4 o'clock, are mostly lower than the average of the day. The noon observations come nearest the mean of the day.

The barometer—at least in the Mississippi valley—is usually highest with westerly and northwesterly winds, and lowest with southerly and southeasterly winds. It is mostly higher, but much more irregular, in winter, and lower but more regular in summer.

BAROMETRICAL ELEVATION OF BAROMETER E., AT ST. LOUIS, 482 FEET ABOVE THE GULF.

Table of monthly barometrical means at St. Louis, corrected for temperature.

June	1853	29.466
July	do	29.483
August	do	29.431
September	do	29.474
October	do	29.538
November	do	29.601
December	do	29.508
January	1854	29.577
February	do	29.507
March	do	29.459
April	do	29.444
May	do	29.334
June	do	29.418
July	do	29.491

DR. GEO. ENGELMANN.

ST. LOUIS, *September*, 1854.

II.—*Barometric and Meteorological Observations and Table of Altitudes and Distances for the Profile of the line of survey from Westport to Great Salt Lake City.*

Station.	Day.	Hour.	Distance from Westport.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp No. 1, 3 miles west of Westport.	June 17	11 a. m	3	744.4		743							NOTE.—The arrangement of the results of the corrected barometric readings, computed in means at camps or stations, is, to place them opposite the *last* observations made at the locality; those of barometer No. 496 being entered first or above in the column. The altitudes are entered opposite the *first* readings at the camp or station.
	17	2 p. m		744.7		741.2							
	17	3.30 p. m		738.7		742.7							
	17	6.30 p. m		742		742.6							
	18	9 a. m		742.4		742		84					
	18	12.30 p. m		742.6		740.6		87.5					
	18	3.30 p. m		740.9		740.5		89.5					
	18	8 p. m		739.6				77					
	19	6.30 a. m		739.3		740.6		74.5					
	19	9 a. m		739.8		740.6		83.5					
	19	1 p. m		739.3		739.5		90					
	19	3 p. m		738.9		739.8		93					
	19	8 p. m		737.7		739.9		80					
	20	6 a. m		738.2		740.4		74					
	20	5 p. m		738.2		739.4		94					
	20	9 p. m		737.4		738.7		78					
	21	6 a. m		736.7		736.7							
				737.2	Mean attached thermometer, 33°.2, (C.)	738.6	Mean attached thermometer, 33°.2, (C.)						
				735.6		735.6			28.959	28.975	28.967	990.6	
Camp 18, Pawnee fork	July 13	7 p. m	297.50	714.6	30	712.8	30	84	28.016	27.945		1962	Cloudy in northwest; light southwest wind.
	13	9 p. m		713.6	27	713.9	27	80	27.973	27.984	28.020		Do do.
	14	6 a. m		715.8	22	715	22	69	28.076	28.044	27.992		Cloudy; wind southwest.
Camp 19, first Coon creek	14	3 p. m	318.21	717.5	35.5	715.2	36	77	28.117	28.026	28.050	2004	Cloudy, with rain; strong northwest wind.
	15	6 a. m		714.3	28.5	716	28.5	72	27.985	28.052	28.040		Do do.
Camp 20, second Coon creek	15	3 p. m	336.71	703.2	32	704.9	31	87	27.574	27.644		2244.6	Cloudy.
	15	6 p. m		705.6	27.5	706.3	28	81	27.688	27.715			Light southeast wind; clouds in southwest.
	15	9 p. m		706.8	23	707.4	23.5	73	27.725	27.774	27.702		Hazy.
	16	6 a. m		709.5	21.5	712.6	21.5	72	27.832	27.954	27.765		Light clouds.
Camp 21, near Fort Atkinson, Arkansas river.	16	4.30 p. m	365.33	698.4	25.5	700.2	25.5	88	27.427	27.502		2330.7	Clear; light breeze from southeast.
	16	6 p. m		704.9	26.5	706.7	27.5	75	27.664	27.731			Do do.
	16	9 p. m		708.2	23	699.5	23	74	27.780	27.438			Light clouds in east; wind southeast.
	17	6 a. m		705.5	21	705.9	21	70	27.674	27.690			Clear; wind southeast.
	17	9 a. m		701	27.5	700.6	27.5	83	27.433	27.417			Do.
	17	12 m		708.5	32.5	706.1	33	93	27.723	27.633			Clear.
	17	3 p. m		705.5	31.5	704.3	31.5	88	27.664	27.617			Stormy, with thunder.

	17	6 p. m		703.6	28.5	702.6	28.5	83	27.605	27.566			Do.
	17	9 p. m		694.8	28	697.3	28	83	27.233	27.331			Do.
	18	6 a. m		701.6	22	704.6	22	71	27.517	27.635			Cloudy, strong wind from northeast.
	18	9 a. m		704.5	27.5	703.6	28	84	27.574	27.535			Cloudy in southeast.
	18	12 m		705.9	31.5	704.1	31.5	92	27.625	27.554			Cloudy in north; wind from southeast.
	18	3 p. m		706.1	30.5	705.1	30.5	86	27.692	27.652			Light clouds in southeast; wind northeast.
	18	6 p. m		706.1	23	704.7	23	72	27.727	27.672			Cloudy; strong wind from northeast.
	18	9 p. m		706.4	21	705.1	21	70	27.717	27.666	27.624		Rain; strong wind from northeast.
	19	6 a. m		703.9	20	704	20	68	27.615	27.619	27.596		Cloudy; light northeast breeze.
Camp 22, on Arkansas river.	19	3.30 p. m	390.65	702.8	28.5	703.5	29	84	27.574	27.597		2431.2	Cloudy in northwest; light southeast breeze.
	19	6 p. m		704.1	25	703.2	24.5	77	27.640	27.605			Do do.
	19	9 p. m		703	23	704.3	23.5	75	27.575	27.622	27.623		Do do.
	20	6 a. m		706.5	21	705.5	21	69	27.714	27.674	27.623		
Camp 23, Arkansas river	20	1.30 p. m	410.55	702.3	30	703	30	87	27.526	27.554		2556.2	Cloudy in northeast; light northeast wind.
	20	3 p. m		698.9	30.5	696.4	30.5	88	27.412	27.314			Cloudy in northeast; light south west wind.
	20	6 p. m		701.5	27.5	700.4	27.5	82	27.527	27.483			Cloudy in northwest; light northeast wind.
	20	9 p. m		699.2	23.5	699	23.5	76	27.426	27.418	27.451		
	21	6 a. m		697.7	21.5	698	21.5	72	27.368	27.379	27.431		Light clouds; light northeast wind.
Camp 24, Arkansas river	21	2.30 p. m	432.60	697.8	32.5	698.4	33	91	27.354	27.366		2692.2	Light clouds in southwest.
	21	3 p. m		696.8	33	696.6	33	91	27.318	27.310			Do do.
	21	6 p. m		696.1	29	696.9	29	85	27.310	27.342			Do do.
	21	9 p. m		695.6	24.5	695.1	24.5	78	27.280	27.264	27.298		Do do.
	22	6 a. m		694.4	20.5	698.4	20.5	69	27.242	27.399	27.337		Cloudy in west; light northwest wind.
Camp 25, Arkansas river	22	2 p. m	454.33	695.2	29	696.7	29.5	79	27.260	27.315		2852	Light clouds; wind southeast.
	22	3 p. m		694.7	30	693.1	30.5	86	27.247	27.184			Do do.
	22	6 p. m		691.6	27	692.5	27	81	27.180	27.176			Cloudy in west; wind southeast.
	22	9 p. m		687.5	23	691	23	73	26.969	27.107	27.129		Cloudy; wind southeast.
	23	6 a. m		689.1	20	690.8	20	68	27.037	27.104	27.176		Do do.
Camp 26, Arkansas river	23	2.30 p. m	478.71	684.6	36.5	685.4	36.5	94	26.870	26.898		3047.3	Cloudy; light southeast breeze.
	23	6 p. m		680.3	26.5	685.4	26.5	80	26.895	26.856			Cloudy in southwest; southeast breeze.
	23	9 p. m		685.0	23	685.7	23	75	26.917	26.744			Do do.
	24	6 a. m		685.6	21	684.6	21	72	26.810	26.723			Clear.
	24	9 a. m		687.6	26.5	683.4	28	84	26.814	26.794			Light clouds in northwest.
	24	12 m		684.8	29	682.8	30.5	88	26.841	26.967			Light clouds; strong northeast wind.
	24	3 p. m		683.1	25.5	682.6	25.5	79	26.973	26.811			Cloudy; strong northeast wind.
	24	6 p. m		683.4	21.5	686.6	21.5	71	27.021	26.974			Rain.
	24	9 p. m	478.71	687.1	18.5	683.1	19	67	26.973	26.969	26.892		Cloudy; light northeast wind.
	25	6 a. m		688.2	15	687	15.5	61	27.035	26.988	26.845		Cloudy in north.
Camp 27, Big Timbers of Arkansas river.	25	2 p. m	500.58	684.3	22	683.5	22	72	26.862	26.830		3166.2	Clear; light breeze from northeast.
	25	6 p. m		687.3	20	683.7	20	68	27.003	26.861			Cloudy in west; light breeze from northeast.

NOTE.—It is to be noted that in the entries in the column headed "barometric means" the first entry is the mean of barometer No. 496; the second is the mean of barometer No. 551. This note applies to the entire table.

II.—*Barometric and Meteorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from Westport.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 27—Continued.....	July 25	9 p. m	.....	686.8	18	686.7	18	66	26.961	26.965	26.950	.....	Cloudy; light breeze from northeast.
	26	6 a. m.....	.....	687.2	15	686.4	15	59	26.985	26.954	26.899	.....	Do do.
Camp 28, Timbers of Arkansas river.	26	2.15 p. m...	520.86	680.5	21.5	677.2	22	70	26.712	26.582	.....	3328.5	Broken clouds; light southwest breeze.
	26	3.15 p. m...	.....	682	22.5	680.8	22.5	73	26.782	26.696	.....	.....	Do do.
	26	6 p. m.....	.....	677.3	24.5	679.3	20.5	69	26.609	26.688	.....	.....	Do do.
	26	9 p. m.....	.....	682.4	16.5	679.4	16.5	63	26.796	26.678	26.727	.....	Clear; light southwest breeze.
	27	6 a. m.....	.....	680.6	12	678.3	12.5	55	26.738	26.643	26.656	.....	Light clouds in the east.
Camp 29, Arkansas river....	27	3.30 p. m...	544.12	676.4	30	674.8	31	82	26.500	26.434	.....	3536.6	Clear; light breeze from northeast.
	27	6 p. m.....	.....	674.7	25	676.3	25	78	26.487	26.550	.....	.....	Dark clouds in west.
	27	9 p. m.....	.....	676.2	21	673.1	21	71	26.532	26.410	26.512	.....	Cloudy; light northeast wind.
	28	6 a. m.....	.....	675.9	19	676.6	19	57	26.521	26.549	26.489	.....	Clear; light northeast wind.
Camp 30, Arkansas river, near Bent's Fort.	28	2 p. m.....	559.20	674.6	31	674.6	31	87	26.441	26.441	.....	3671.5	Light clouds; southeast wind.
	28	3 p. m.....	.....	672.7	30	672.5	29.5	87	26.385	26.381	.....	.....	Do do.
	28	6 p. m.....	.....	670.3	26.5	674.4	27	81	26.306	26.468	.....	.....	Clear; southeast wind.
	28	9 p. m.....	.....	670.5	19.5	672.8	20	70	26.355	26.402	26.348	.....	Cloudy; southeast wind.
	29	6 a. m.....	.....	668.5	12.5	673.1	12.5	55	26.261	26.442	26.428	.....	Do do.
Camp 31, Arkansas river....	29	5 p. m.....	583.20	660.6	25.5	661.5	25.5	78	25.952	25.987	.....	4091.2	Cloudy; strong southwest wind.
	29	9 p. m.....	.....	660.5	19	661.8	19	63	25.926	25.977	25.948	.....	Stormy; light southwest wind.
	30	6 a. m.....	.....	661.2	15.5	661.9	15.5	50	25.962	25.990	25.983	.....	Clear.
Camp 32, ford of Arkansas..	30	2 p. m.....	593.20	661	27	661.5	27.5	81	25.925	25.945	.....	4370.6	
	30	5 p. m.....	.....	660.3	25.5	660.5	25.5	77	25.940	25.948	.....	.....	Light clouds; breeze from southeast.
	30	7 p. m.....	.....	658.3	21	657.5	21	71	25.851	25.820	.....	.....	Light clouds; breeze from northeast.
	30	9 p. m.....	.....	658.3	21	657.5	21	67	25.831	25.800	.....	.....	Cloudy in southwest; breeze from northeast.
	30	11 p. m....	.....	660.8	17	657.7	17	63	25.925	25.803	.....	.....	Do do.
	31	6 a. m.....	.....	656.9	15	658.8	15	60	25.793	25.867	.....	.....	Cloudy and foggy.
	31	9 a. m.....	.....	657.7	26.5	658.1	27.5	69	25.783	25.756	.....	.....	Light clouds; light southwest wind.
	31	11 a. m.....	.....	656	27	656	27.5	81	25.662	25.658	.....	.....	Do do.
Aug.	1	6 a. m.....	.....	654.5	14	656.4	11.5	53	25.702	25.789	.....	.....	Do do.
	1	9 a. m.....	.....	655.6	32.5	655	31	77	25.638	25.618	.....	.....	Light clouds; light southeast wind.
	1	11 a. m.....	.....	656.1	34.5	655.1	36	91	25.634	25.587	.....	.....	Cloudy; light southeast wind.
	1	1 p. m.....	.....	651.2	33.5	653.1	33.5	93	25.495	25.570	.....	.....	Dark clouds in west; light southeast wind.
	1	3 p. m.....	.....	653.9	33.5	649.6	33.5	89	25.622	25.452	25.746		
	2	6 a. m.....	.....	653	12	656.8	12	55	25.651	25.801	25.742		

Camp 33, Apishpa river.....	2	4.30 p. m...	607.84	648.5	33.5	645.8	33.5	92	25.439	25.333	.....	4723.1	Cloudy; light southwest wind.
	2	6 p. m.....	.....	647.8	29.5	648.3	30	85	25.412	25.432	.....	.....	Do do.
	2	9 p. m.....	.....	647.3	20.5	648.4	21	68	25.402	25.441	25.395	.....	Dark clouds in the northwest.
	3	6 a. m.....	.....	645.6	20	645.8	20.5	69	25.328	25.336	25.384	.....	Light hovering clouds.
Camp 34, Apishpa river.....	3	2 p. m.....	620.82	643.5	33	643.7	33.5	91	25.216	25.220	.....	4860	Cloudy; light southwest wind.
	3	3 p. m.....	.....	643.6	25	644.2	27.5	78	25.267	25.282	.....	.....	Rain; fresh southeast breeze.
	3	6 p. m.....	.....	642.2	25	643.1	25.5	78	25.211	25.247	.....	.....	Light hovering clouds.
	3	9 p. m	.....	642.2	18	642.4	18	67	25.213	25.221	25.232	.....	Clear.
	4	6 a. m.....	.....	642.7	12	642.9	12	53	25.249	25.257	25.248	.....	Light clouds in the southeast.
Camp 35, plain near Apishpa river.	4	3.30 p. m...	636.08	625	30.5	625.5	31.5	86	24.520	24.535	.....	5702	Light clouds; light breeze from southeast.
	4	6 p. m.....	.....	623.4	20.5	623.3	20.5	69	24.491	24.487	.....	.....	Cloudy; light breeze from southeast.
	4	9 p. m.....	.....	624.3	20.5	622.8	20.5	70	24.496	24.437	24.492	.....	Do do.
	5	6 a. m.....	.....	623.1	15	623.5	15	60	24.466	24.482	24.484		
Camp 36, plain near Cuchara river.	5	6 p. m.....	653.15	618	20	620.3	20	71	24.282	24.373	.....	5851.2	Dark clouds; strong wind from northeast.
	5	9 p. m.....	.....	617.8	18	619.8	18	69	24.252	24.363	24.284	.....	Do do.
	6	6 a. m.....	.....	618.9	12.5	620.5	12.5	56	24.312	24.375	24.371	.....	Clear; light breeze from northeast.
Camp 37, Cuchara river....	6	3.40 p. m...	663.54	615.5	32.5	615.9	30.5	84	24.138	24.161	.....	6109	Light clouds; light southeast wind.
	6	6 p. m.....	.....	616.6	27	615.9	27	80	24.200	24.172	.....	.....	Do do.
	6	9 p. m.....	.....	616	22	616.4	22	68	24.170	24.142	.....	.....	Clear; strong southeast wind.
	7	6 a. m.....	.....	617.4	16	617.8	16	60	24.237	24.253	.....	.....	Do do.
	7	9 a. m.....	.....	617.5	26	616.4	.....	75	24.169	24.130	.....	.....	Do do.
	7	12 m.....	.....	616.9	33	616.3	.....	89	24.129	24.105	.....	.....	Do do.
	7	3 p. m.....	.....	615.8	32	612.8	32	91	24.145	24.026	.....	.....	Light clouds in southwest; light southwest wind.
	7	6 p. m.....	.....	614.7	25.5	613.7	26	79	24.129	24.030	.....	.....	Light clouds in southwest; light northeast wind.
	7	9 p. m.....	.....	615.8	22.5	615.2	22.5	76	24.154	24.130	24.159	.....	Do do.
	8	6 a. m.....	.....	614.7	20	615	21	72	24.115	24.123	24.135	.....	Light clouds; strong southwest wind
Camp 38, Huerfano river, near butte.	8	2 p. m.....	673.63	617.3	33.5	618.6	.....	96	24.180	24.240	.....	6099.1	Dark clouds; light southwest breeze.
	8	3 p. m.....	.....	616.2	31	615.5	31	85	24.168	24.141	.....	.....	Do do.
	8	6 p. m.....	.....	615	29.5	614	29.5	84	24.125	24.086	.....	.....	Do do.
	8	9 p. m.....	.....	616	21	615.7	21	71	24.170	24.158	24.176	.....	Do do.
	9	6 a. m.....	.....	617.2	18	615.4	18	65	24.222	24.151	24.156	.....	Do do.
Camp 39, Huerfano river...	9	3.30 p. m...	688.17	600.4	32.5	600.2	32	93	23.543	23.535	.....	6976.1	Light clouds; light southwest wind.
	9	6 p. m.....	.....	600.1	31	599.9	31	88	23.534	23.526	.....	.....	Light clouds.
	9	9 p. m.....	.....	599.3	20.5	599.4	21	69	23.516	23.520	.....	.....	Clear.
	9	12 m.....	.....	598.9	20	598.8	20	72	23.474	23.470	.....	.....	Clear; light northeast breeze.
	10	3 a. m.....	.....	599.6	20	599.5	20	69	23.539	23.535	23.528	.....	Do do.
	10	6 a. m.....	.....	599.3	18	599.1	18	65	23.553	23.545	23.529	.....	Dark clouds.
Camp 40, base of the Sierra Blanca.	10	2.30 p. m ..	695.76	584.4	19.5	583.6	19.5	67	22.954	22.923	.....	7463.3	Stormy.
	10	3 p. m.....	.....	584.1	18	583.2	18	65	22.999	22.964	.....	.....	Rain; light southwest wind.
	10	6 p. m.....	.....	582.9	16	582.7	16	62	22.956	22.948	.....	.....	Light clouds.
	10	9 p. m.....	.....	583.4	15	583.3	15	60	22.947	22.943	22.953	.....	Do.
	11	6 a. m.....	.....	583.4	15.5	583.9	16.5	60	22.927	22.946	22.945	.....	Light clouds; strong northwest wind.
Camp 41, in Sangre de Cristo Pass.	11	9 a. m.....	700.88	569.3	20	569.2	20	65	21.728	21.720	.....	8757.1	
	11	10 a. m.....	.....	566.5	22.5	567.2	22.5	68	21.684	21.680			
	11	10.30 a. m..	.....	570.1	24	570.1	24	74	21.633	21.648			
	11	11 a. m.....	.....	566.8	12.7	566.4	27	74	22.315	22.313			
	11	12 m.....	.....	560	24	559.6	23.5	75	22.187	22.183			
	11	2 p. m.....	.....	552.4	20	552.2	20	57	22.312	22.312			

II.—*Barometric and Meteorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from West-port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 41—Continued	Aug. 11	3 p. m.	.....	551	13.5	550.9	13.5	57	22.174	22.158			
	11	6 p. m.	.....	549.7	13.5	550.1	13.5	58	21.940	21.925			
	11	9 p. m.	.....	549.8	13	549.6	14	63	21.603	21.591	21.657	.....	Cloudy; light breeze from southwest.
	12	6 a. m.	.....	549.5	12	549.5	12	55	21.580	21.580	21.657	.....	Do do.
Top of mountain	12	9 a. m.	.....	536	17	536.1	17	60	21.039	21.040	.....	9852	Cloudy; strong southwest wind.
First summit of El Saugre de Cristo Pass.	12	10 a. m.	701.58	545.2	14.5	544.2	14.5	58	21.053	21.058	.....	9358	Rain in the distance.
	12	2 p. m.	.....	546.9	17	546.7	17	60	21.511	21.508	.....	.....	Dark clouds.
	12	3 p. m.	.....	546.9	17	546.7	17	60	21.526	21.518	21.408	.....	Rain, with thunder.
	12	4 p. m.	.....	546.7	13.5	546	13.5	56	21.541	21.535	21.404	.....	Rain.
Near Camp 42	13	10 a. m.	.....	552.1	19	548.8	19	63	21.678	21.540	.....	.....	Light clouds; light southeast breeze.
	13	11 a. m.	.....	552.3	18	549.1	18	61	21.705	21.580	.....	.....	Dark clouds; light southeast breeze.
	13	12 m.	.....	552.3	20	548.7	21.5	66	21.735	21.560	.....	.....	Do do.
Second summit of Pass	13	1 p. m.	.....	545.5	16.5	547.3	17	58	21.416	21.467	.....	9219.8	Rain.
	13	2 p. m.	.....	545.5	14	547.3	14	56	21.448	21.515	.....	.....	Do.
	13	3 p. m.	.....	545.5	13.5	547.3	14	55	21.459	21.534	.....	.....	Cloudy.
	13	4 p. m.	.....	545.4	14	546.7	14	56	21.474	21.526	.....	.....	Light clouds; light northwest wind.
	13	5 p. m.	.....	545.4	14	546.7	14	55	21.479	21.531	21.457	.....	Do do.
	13	6 p. m.	.....	545.4	12	546.7	12	53	21.459	21.511	21.517	.....	Do do.
On summit	17	9 a. m.	.....	548.9	17.5	547.7	18	65	21.512	21.464	.....	9396.2	
	17	10 a. m.	.....	548.9	19.5	547.7	20	68	21.502	21.450			
	17	11 a. m.	.....	548.6	21	547.7	21	70	21.465	21.426			
	17	12 m.	.....	548.6	23	547.2	23	75	21.491	21.436	21.488		
	17	1 p. m.	.....	548.6	25	547.2	25	76	21.508	21.453	21.446		
Camp 42, Sangre de Cristo Valley.	14	6 a. m.	705.38	550.5	7	551.1	7	43	21.643	21.667	.....	9041.1	Clear; light northeast breeze.
	14	9 a. m.	.....	551.3	15	550.5	15	58	21.626	21.594	.....	.....	Do do.
	14	11 a. m.	.....	551.6	19.5	550.4	19.5	66	21.591	21.544	.....	.....	Do do.
	14	1 p. m.	.....	552	21	550	21	70	21.649	21.570	.....	.....	Do do.
	14	3 p. m.	.....	552	21	550	21	70	21.685	21.605	.....	.....	Light clouds; northeast breeze.
	14	6 p. m.	.....	552.1	19	551.8	19	45	21.708	21.696	.....	.....	Clear; light southeast breeze.
	14	9 p. m.	.....	550.9	11.5	551.2	11.5	53	21.650	21.662	.....	.....	Light clouds; light southeast breeze.
	15	6 a. m.	.....	552.3	11.5	551.4	11.5	52	21.698	21.663	.....	.....	Cloudy; light southeast breeze.
	15	9 a. m.	.....	552.8	17.5	551.1	17.5	63	21.665	21.598	.....	.....	Do do.
	15	11 a. m.	.....	553.1	21	551	21	69	21.642	21.559	.....	.....	Do do.
	15	1 p. m.	.....	553.6	24	551.2	24	66	21.700	21.605	.....	.....	Do do
	15	3 p. m.	.....	553.6	24	551.2	24	65	21.735	21.640	.....	.....	Light clouds; light southeast breeze.
	15	6 p. m.	.....	552.3	18	550.4	18	65	21.716	21.640	.....	.....	Clear; light southeast breeze.
	15	9 p. m.	.....	551.2	9	550.7	9	49	21.666	21.646	.....	.....	Do do.
	16	6 a. m.	.....	553.1	6	552.4	6	42	21.746	21.722	.....	.....	Do do.
	16	10 a. m.	.....	554.6	22	553	22	71	21.707	21.643	.....	.....	Do do.

	16	12 m		554.4	22	552.9	22	71	21.724	21.664			Do	do
	16	3 p. m.		553.6	22	552.9	22	71	21.779	21.719			Do	do.
	16	6 p. m.		552.7	15	552.3	15	59	21.739	21.723	21.684		Do	do.
	16	9 p. m.			8	551.5	8	52	21.701	21.632	21.645		Do	do.
Camp 43, Sangre de Cristo valley.	17	5.30 p. m.	710.72	567.7	26.5	565.2	24.5	82	22.214	22.202		8412.1	Clear; light breeze from southeast.	
	17	6 p. m.		565.2	25	565.1	25	77	22.192	22.188			Clear.	
	17	9 p. m.		564.3	13.5	563.9	13.5	59	22.174	22.158			Do.	
	18	6 a. m.		564.6	7	565.6	7	42	22.194	22.233	22.183		Do.	
	18	7 a. m.		564.4	13.5	563.5	13.5	57	22.150	22.114	22.179		Do.	
	18	10.30 a. m.		569.9	23.5	568.7	23	73	22.297	22.258			Do.	
	18	11.30 a. m.		569	25	568.3	25	76	22.269	22.241			Do.	
	18	12.30 p. m.		568.7	27.5	567.1	27.5	80	22.273	22.249			Do.	
	18	1.30 p. m.		568.6	28.5	567	28.5	83	22.281	22.217			Do.	
	18	2.30 p. m.		568.6	30	567.5	31	86	22.308	22.264			Do.	
	18	3.30 p. m.		568.3	31.5	566.3	31.5	88	22.291	22.213			Do.	
	18	4.30 p. m.		566.7	31	566.2	30.5	86	22.246	22.217	22.275		Do.	
	18	6 p. m.		566.3	26	565.7	26	79	22.235	22.202	22.232		Do.	
Camp 44, Utah creek, San Luis valley, near Fort Massachusetts.	20	9 a. m.	721.29	569.3	20.5	568.4	20	67	22.239	22.260		8345.1	Cloudy, with thunder.	
	20	11 a. m.		569.4	30	567.5	30	88	22.245	22.170			Rain in distance.	
	20	12 m		568.6	25	567.4	25	79	22.271	22.223			Stormy.	
	20	2 p. m.		567.1	18.5	566.4	19	66	22.283	22.252			Cloudy; light breeze from southeast.	
	20	4 p. m.		567.2	22.5	566.2	22.5	73	22.297	22.258			Do	do.
	20	6 p. m.		566.8	19	566.3	19	67	22.282	22.263			Do	do.
	20	9 p. m.		566.8	15	566.7	15.5	61	22.268	22.260			Do	do.
	21	6 p. m.		566.4	20	566.2	20	68	22.270	22.263			Do	do.
	21	9 p. m.		566	14	566.6	10	62	22.240	22.268			Do	do.
	22	6 a. m.		566	9	565	10	49	22.245	22.198			Do	do.
	22	9 a. m.		567.3	23	566.9	22	77	22.212	22.197			Do	do.
	22	12 m		567.6	25	567.1	25.5	82	22.233	22.215			Dark clouds; light breeze from southeast.	
	22	3 p. m.		567.2	23	567.2	23	77	22.263	22.263			Do	do.
	22	6 p. m.		566.8	15.5	567.4	15.5	60	22.294	22.318			Do	do.
	22	9 p. m.		566.9	13	567.7	13	56	22.276	22.308	22.266		Do	do.
	23	6 a. m.		567	13	568.1	13	61	22.273	22.316	22.250		Do	do.
											22.603			
Crossing Utah creek	23	11 a. m.	725.25	577.8	24	576.5	23.5	83	22.603	22.569	22.569	8079.1		
Camp 45, White Mountain spring.	23	2 p. m.	732.04	578	25	577.4	26	76	22.681	22.653		7829.1	Light clouds; slight northeast wind.	
	23	4 p. m.		576.8	21	575.9	21	70	22.675	22.640			Light clouds; strong northeast wind.	
	23	6 p. m.		576.8	18	575.9	18	64	22.680	22.645			Do	do.
	23	9 p. m.		577.3	15	576.8	15	58	22.678	22.658	22.675		Clear; strong northeast wind.	
	24	6 a. m.		577	14	577.1	14	57	22.667	22.671	22.652		Light clouds; light northeast breeze.	
Foot of Roubideau's Pass	24	5.30 p. m.				572.6	15	58		22.549			Not used in general profile.	
	24	6 p. m.				572.6	15	56		22.539				
	24	6.30 p. m.				572.4	14	54		22.526	22.473			
Camp 46, near Roubideau's Pass.	25	6 a. m.	745.50			581.2	11	57		22.836		7638	Light clouds; light southeast breeze.	
	25	7.30 a. m.				581.3	13	60		22.814			Do	do.
	25	8 a. m.				582	18.5	70		22.821			Do	do.
	25	8.30 a. m.				582.7	19	74		22.804			Do	do.
	25	9 a. m.				582.7	19.5	75		22.795	22.832		Do	do.
Camp 47, near Williams' Pass.	25	4 p. m.	755.28			579.4	25	77		22.766		7723.1	Dark clouds.	
	25	6 p. m.				579.8	24	75		22.767			Do.	
	25	9 p. m.		581.4	17	580.4	16.5	64		22.796			Do.	
	26	6 a. m.		581.3	16	580.7	16.5	60		22.801	22.781		Do.	

II.—*Barometric and Meteorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from West-port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 48, Chatillon's creek.	Aug. 26	6 p. m.....	764.34	583.8	21	583.4	21	69	22.937	22.921	.....	7503.2	Dark clouds.
	26	9 p. m.....	.....	583.2	15	583.5	15	60	22.910	22.922	22.910	.....	Do.
	27	6 a. m.....	.....	583.8	12	583.5	12	55	22.935	22.923	22.906	.....	Rain.
Camp 49, Leroux's creek...	27	3 p. m.....	776.'6	583.8	23	583.5	23	72	22.933	22.921	.....	7698.2	Dark clouds; light breeze from southeast.
	27	6 p. m.....	.....	582.2	18	582.4	18	65	22.893	22.901	.....	.....	Do do.
	27	9 p. m.....	.....	582.2	15.5	582.4	15.5	61	22.871	22.879	.....	.....	Do do.
	28	6 a. m.....	.....	582.3	11	582.8	11	52	22.876	22.896	.....	.....	Do do.
	28	9 a. m.....	776.06	583.1	15	582.7	15	61	22.867	22.863	.....	.....	Do do.
	28	11 a. m.....	.....	583.8	21.5	582.2	22	76	22.852	22.788	.....	.....	Light clouds; light breeze from southeast.
	28	1 p. m.....	.....	583.8	25	582.2	25	81	22.890	22.826	.....	.....	Do do.
	28	3 p. m.....	.....	582.4	27	581.2	27	82	22.861	22.814	.....	.....	Do do.
	28	6 p. m.....	.....	581	18	581.5	18	67	22.846	22.865	22.868	.....	Do do.
	28	9 p. m.....	.....	581	17	581.5	17	65	22.820	22.839	22.856	.....	Do do.
Camp 50, Homans' creek..	29	1 p. m.....	782.02	584.1	25.5	584.9	25	74	22.898	22,933	.....	7548.3	Light clouds; light southeast breeze.
	29	3 p. m.....	.....	583.4	27	583	27	82	22.901	22.885	.....	.....	Dark clouds; light southeast breeze.
	29	6 p. m.....	.....	582.4	20	583.3	20	69	22.893	22.929	22.919	.....	Do do.
	30	6 a. m.....	.....	584.9	12	584.9	12	54	22.978	22.978	22.930	.....	Clear; light southeast breeze.
											22.938		
Sahwatch spring and Butte.	30	12.30 p. m..	792.56	585.5	27	582.8	27	81	22.938	22.842	22.842	7676.2	Clear.
Camp 51, Sahwatch creek.	30	3 p. m.....	797.22	582.7	27	582.7	27	76	22.873	22.873	.....	7567.1	Do.
	30	6 p. m.....	.....	582.1	22	582.4	22	72	22.869	22.881	.....	.....	Do.
	30	9 p. m.....	.....	582.4	16	583	16	61	22.879	22.903	22.856	.....	Do.
	31	6 a. m.....	.....	580	6	580.7	6	43	22.805	22.832	22.872	.....	Do.
Camp 52, approach to Coochetopa Pass.	31	12.30 p. m..	809.49	572.3	27	571.4	27	75	22.422	22.387	.....	8047	Light clouds; light southeast wind.
	31	3 p. m.....	.....	570	18	570.2	18	61	22.413	22.421	.....	.....	Rain and hail; strong southwest wind.
	31	6 p. m.....	.....	571.1	17	570.7	17	60	22.460	22.444	22.477	.....	Dark clouds.
	Sept. 1	6 a. m.....	.....	572.8	11	573.5	12	50	22.502	22.529	22.443	.....	Rain.
Camp 53, foot of Coochetopa Pass.	1	4.30 p. m...	824.49	552.9	18	552.5	17	64	21.754	21.738	.....	8960.2	Light clouds; light southwest breeze.
	1	6 p. m.....	.....	553	20	552.3	20	60	21.735	21.708	.....	.....	Do do.
	1	9 p. m.....	.....	551.7	12	552.8	12	55	21.674	21.717	21.680	.....	Clear; light southeast breeze.
	2	6 a. m.....	.....	551.6	5	552.1	5	36	21.690	21.710	21.684	.....	Do do.
Coochetopa Pass—													
1st station.....	2	9.55 a. m...	.....	.....	.....	555.6	22	65	.....	21.817	21.817	8898	
2d station.....	2	10.55 a. m..	826.11	.....	.....	550.3	23	68	.....	21.627	21.627	9210	

3d station	2	11.55 a. m.	827.50	.....	.....	544.1	25	65	.....	21.340	21.340	9510	
4th station	2	12.55 p. m.	828.08	.....	.....	540	23	64	.....	21.195	21.195	9740.3	
5th on summit of pass	2	1.15 p. m.	828.32	532.3	15	532.9	15	59	.....	20.935	20.935	10032.0	
Do	2	2 p. m.	.....	.....	.....	532.8	13	58	.....	20.905	20.905	10032.0	
Camp 54, west of pass	2	3 p. m.	829.65	542.3	20	542.1	20	61	21.314	21.306	.....	9540	Dark clouds; strong wind from W.
	2	6 p. m.	.....	541.8	19	541.9	19	66	21.298	21.302	.....	.....	Light clouds; light southeast breeze.
	2	9 p. m.	.....	541.8	15	541.7	15	62	21.684	21.280	21.289	.....	Do do.
	3	6 a. m.	.....	541.4	11	540.7	11	55	21.265	21.234	21.281	.....	Clear.
Camp 55, near Camp Rock	3	6 p. m.	849.65	563.6	24	564.2	23	68	22.133	22.160	.....	8515	Cloudy; light breeze from west.
	3	9 p. m.	.....	562.2	13	562.5	13.5	59	22.091	22.103	.....	.....	Clear and calm.
	4	6 a. m.	.....	562.4	9	563.4	9	49	22.104	22.143	.....	.....	Do.
	4	9 a. m.	.....	564	19	563.3	19	65	22.102	22.065	.....	.....	Light clouds; light southeast breeze.
	4	11 a. m	.....	564	22	563.4	22	71	22.067	22.044	.....	.....	Dark clouds in the northwest.
	4	1 p. m.	.....	564.3	22	563.4	24	78	22.129	22.040	.....	.....	Rain; light southwest breeze.
	4	3 p. m.	.....	563.9	21	563.7	21.5	71	22.152	22.145	.....	.....	Do do.
	4	6 p. m.	.....	563.3	13	564.7	13.5	59	22.150	22.212	.....	.....	Dark clouds.
	4	9 p. m.	.....	558.4	13	558.1	13.5	60	21.938	21.922	22.091	.....	Do.
	5	6 a. m.	.....	562.7	8	563.2	8	40	22.115	22.135	22.091	.....	Clear.
Camp 56, Coochetopa creek	5	4 p. m.	865.53	577.3	20	577.6	20	68	22.707	22.719	.....	7681.2	Dark clouds.
	5	6 p. m.	.....	577.5	15	578.9	15	61	22.710	22.767	.....	.....	Do.
	5	8.30 p. m.	.....	577.6	15	578.2	15	56	22.688	22.711	22.703	.....	Clear.
	6	6 a. m.	.....	577.5	4	577.9	4	36	22.714	22.730	22.731	.....	Do.
Camp 57, Grand river	6	5 p. m.	880.28	583.5	22	584.5	22	72	22.941	22.968	.....	7428	Do.
	6	6 p. m.	.....	583.2	19.5	584.4	19.5	67	22.925	22.972	.....	.....	Do.
	6	9 p. m.	.....	582.6	13	584.2	13	57	22.891	22.953	22.917	.....	Do.
	7	6 a. m.	.....	582.4	4	584.9	4	36	22.907	23.006	22.975	.....	Do.
Camp 58, Grand river	7	6 p. m.	894.28	587.5	25	587.8	25	65	23.070	23.082	23.079	7293.1	Do.
	7	9 p. m.	.....	587.4	10.5	588.5	10	61	23.083	23.127	23.102	.....	Clear; light southwest breeze.
Camp 59, ravine near Grand river.	8	5.30 p. m.	898.28	579.7	23.5	579.6	23.5	75	22.786	22.782	.....	7639.1	Light clouds; southwest breeze.
	8	9 p. m.	.....	579	18	579.4	18	68	22.737	22.752	.....	.....	Do do.
	9	6 a. m.	.....	578.4	2	579.4	2	35	22.757	22.797	22.766	.....	Do do.
	9	8 a. m	.....	580.4	10	580.4	10	55	22.782	22.782	22.778	.....	Do do.
	9	3 p. m.	.....	577.3	25.5	577.7	25	60	22.668	22.686	.....	.....	Do do.
Summit of right bank of Lake Fork.	9	4 p. m.	.....	571.6	25.5	571.7	25	76	22.459	22.463	.....	8171.2	Do do.
Camp 60, Lake Fork, (on stream.)	9	5.30 p. m.	902.28	588.9	22.5	589.4	22	72	23.143	23.163	.....	7236.2	Do do.
	10	6 a. m.	.....	587.7	10	589.4	10	56	23.092	23.159	.....	.....	Do do.
	10	8 a. m.	.....	588.1	12.5	592.2	12.5	60	23.077	23.238	.....	.....	Do do.
	10	9 a. m.	.....	591.1	19	590.2	19	62	23.165	23.130	23.126	.....	Do do.
	10	10 a. m.	.....	591.1	20	590.2	20	70	23.151	23.155	23.161	.....	Do do.
Summit of left bank of Lake Fork.	10	1.20 p. m.	.....	581.4	23.5	581.5	23.5	71	22.802	22.806			
	10	2.15 p. m.	.....	580.9	23.5	580.9	24.5	71	22.799	22.795			
											22.793	7716.2	
	10	2.30 p. m.	.....	580.4	24	580.6	24.5	73	22.780	22.788	22.796		
Camp 61, Mountain creek	10	7 p. m.	906.98	572	16	573.1	16	62	22.489	22.533	.....	8054.3	Dark clouds; light breeze from northeast.
	10	9 p. m.	.....	571.3	12	572.2	12	60	22.445	22.481	.....	.....	Do do.
	11	6 a. m.	.....	571.2	10	572.3	10	46	22.442	22.486	.....	.....	Do do.
	11	9 a. m.	.....	571.3	12	572.3	12	69	22.405	22.445	.....	.....	Rain; light breeze from southeast.
	11	12 m.	.....	571.7	18	571.3	18	70	22.420	22.405	.....	.....	Dark clouds; light breeze from northeast.
	11	3 p. m.	.....	570	18.5	570.8	18.5	67	22.405	22.436	.....	.....	Do do.
	11	6 p. m.	.....	569.8	15.5	570.1	15.5	67	22.405	22.407	.....	.....	Do do.

II.—*Barometric and Metcorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from West-port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches*	*Feet.*	
Camp 61—Continued	Sept. 11	9 p. m.	.....	569	10	570	10	59	22.363	22.402	22.418	.....	Dark clouds; light northeast breeze.
	12	6 a. m.	.....	569.2	4	570.7	4	35	22.388	22.446	22.449	.....	Do do.
On succeeding creek	12	8 a. m.	910.02	568.7	16	568.4	15	67	22.305	22.293	.....	8297.2	
On summit of mesa	12	9.30 a. m.	911.10	558.2	17	558.4	17	60	22.267	22.254	.....	8286.2	
On small creek	12	10.20 a. m.	911.79	568.2	17.5	568.4	17.5	69	22.260	22.247	.....	8373	Rain.
On second small creek	12	1.30 p. m.	913.81	563.7	20	564.1	19.5	73	22.124	22.144	.....	8559	
Camp 62, Cebolla creek, first branch.	12	7 p. m.	920.16	590.6	13	598.4	13	55	23.221	23.528	.....	7026.4	Light clouds; light southeast breeze.
	12	9 p. m.	.....	589.3	11	590.7	11	51	23.158	23.213	23.170	.....	Do do.
	13	6 a. m.	.....	588.6	9	589.6	9	47	23.132	23.171	23.304	.....	Do do.
Camp 63, Cebolla creek, second branch.	13	12 m.	923.91	588.9	22.5	589.1	22.5	66	23.078	23.086	.....	7355.1	Dark clouds; light southwest breeze.
	13	3 p. m.	.....	587.3	23	587.2	23	78	23.070	23.066	.....	.....	Do do.
	13	6 p. m.	.....	586.4	17	587.4	17	64	23.362	23.101	23.052		
	13	9 p. m.	.....	585.3	12	586.5	12	60	22.997	23.044	23.077		
Summit of mountain	14	10 a. m.	927.71	560	18.5	561.2	18.5	68	21.920	21.970	21.945	8755	
Camp 64, Cedar creek	14	Night.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	No barometric observations at this camp.
	15	Morning.	936.91										
Crossing, Cedar creek	15	10 a. m.	938.91	599.1	21.5	598.6	21.5	76	23.454	23.435	23.444	6962	
Camp 65, Uncompahgra river	15	4 p. m	949.20	617.3	27.5	615.2	27.5	82	24.238	24.156	.....	6085	Clear; fresh breeze from southeast.
	15	5 p m	.....	617.3	27.5	615.2	27.5	81	24.243	24.161	.....	.....	Do do.
	15	6 p. m	.....	616	25	615	25	79	24.180	24.141	.....	.....	Do do.
	15	8 p. m	.....	615.7	21	614.9	21	71	24.159	24.127	.....	.....	Do do.
	15	9 p. m	.....	615.2	12	613.3	12	64	24.174	24.099	24.190	.....	Do do.
	16	6 a. m	.....	614.8	14	614.5	14	59	24.143	24.131	24.135	.....	Light clouds.
Camp 66, Uncompahgra river	16	3 p. m	967.43	632.4	26.5	631.9	26.5	79	24.822	24.802	.....	5331.9	Cloudy; strong southwest wind.
	16	5 p. m	.....	631.9	25	630.2	25	77	24.826	24.759	.....	.....	Do do.
	16	6 p. m	.....	631.9	25	630.2	25	73	24.806	24.739	.....	.....	Do do.
	16	9 p. m	.....	631.3	15	629.3	15	61	24.796	24.717	24.809	.....	Do do.
	17	6 a. m	.....	630.4	5	629.8	5	37	24.793	24.769	24.757	.....	Clear; light southwest breeze.
Camp 67, on hill	17	Night.	987.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	No barometric observations.
Camp 68, Kah-nah creek	18	11 a. m	996.21	646	21.5	646.4	21.5	66	25.292	25.308	.....	4703.6	Clear; light southeast breeze.
	18	1 p. m	.....	645.2	20	645.6	20	66	25.314	25.314	.....	.....	Do do.
	18	3 p. m	.....	645.2	23	645.6	23	69	25.338	25.353	.....	.....	Do do.
	18	6 p. m	.....	643.6	20.5	645	20.5	67	25.286	25.341	.....	.....	Do do.
	18	9 p. m	.....	643.9	12	645.4	12	51	25.304	25.363	25.295	.....	Do do.
	19	6 a. m	.....	642.2	3	645.3	3	35	25.265	25.387	25.346	.....	Do do.
Creek	19	10.30 a. m.	1000.43	651.8	27	652.4	27	63	25.500	25.523	.....	4514.6	
Small ridge	19	11.30 a. m.	1003.21	649.2	24	648.1	24	87	25.421	25.378	.....	4754.2	
Second ridge	19	12.30 a. m.	1004.93	645.1	24	644.9	24	87	25.285	25.277	.....	4886.4	
Foot of ridge	19	12.45 p. m.	1006.07	649.7	27.5	649.3	27.5	89	25.454	25.438	.....	4710.5	

Camp 69, Blue river	19	2 p. m	1009.61	652.1	23.5	652.3	23.5	87	25.594	25.602		4449	Clear; light breeze from southeast.		
	19	2.30 p. m		652.1	23.5	652.3	23.5	87	25.604	25.612			Do	do.	
	19	6 p m		651	21	650.5	21	68	25.574	25.554			Do	do.	
	19	9 p. m		649.9	10.5	650.4	10.5	50	25.544	25.563			Do	do.	
	20	6 a. m		650.5	10.5	651.9	10.5	50	25.560	25.615	25.574		Do	do.	
	20	7.15 a. m		651.2	13	652.6	13	57	25.567	25.622	25.594		Do	do.	
Camp 70, Blue river	20	1 p. m	1018.71	655.9	32	655.8	32	92	25.688	25.684		4410.3	Do	do.	
	20	3 p. m		655.6	33	653.4	33	95	25.684	25.617			Do	do.	
	20	5 p. m		654	26.5	651.2	26.5	83	25.688	25.625			Do	do.	
	20	9 p. m		652.5	10	650.6	10	54	25.650	25.575	25.679		Do	do.	
	21	6 a. m		653.3	10	652.9	10	43	25.675	25.659	25.624		Do	do.	
Camp 71, Little Salt creek	21	4 p. m	1033.00	656.6	20.5	654.7	20.5	87	25.813	25.738		4274.1	Do	do.	
	21	9 p. m		653.8	15	653	15	63	25.678	25.646	25.742		Do	do.	
	22	6 a. m		654.2	5	653.9	5	31	25.730	25.718	25.698		Do	do.	
Noon halt	22	12 m	1042.11	646.1	27	646.2	27	86	25.302	25.306		4855.6	Do	do.	
Camp 72, Bitter Water creek	23	6 a. m	1054.75	655.2	2	653.2	2	32	25.781	25.702		4486.4	Do	do.	
	23	9 a. m		655.5	19	653.8	19	56	25.689	25.622			Do	do.	
	23	12 m		655.7	33.5	653.7	33.5	91	25.653	25.574			Do	do.	
	23	3 p. m		654.4	36.5	652	36.5	90	25.644	25.550			Do	do.	
	23	6 p. m		652.7	26	651.1	24	78	25.621	25.566			Do	do.	
	24	6 a. m		651.3	6	651.1	6	32	25.611	25.604			Do	do.	
	24	6 p. m		648.9	19	646.4	19	76	25.503	25.404			Do	do.	
	24	9 p. m		647.7	15.5	647	15.5	60	25.437	25.410			Do	do.	
	25	6 a. m		649.4	13	648.2	13	58	25.509	25.462	25.575		Rain; light breeze from southwest.		
	26	7 a. m		651.5	16	651.6	16	58	25.563	25.567	25.524		Do	do.	
Camp 73, Rain Water creek	26	6.30 p. m	1071.03	648.3	18	647.6	18	64	25.474	25.447	25.557	4154.3	Cloudy; light breeze from southwest.		
	27	6 a. m		651.8	4	649.6	4	45	25.639	25.552	25.498		Do	do.	
Camp 74, on hill	27	5 p. m	1076.70	640.8	19	642.1	19	62	25.204	25.251		4856.2	Rain.		
	27	8 p. m		640.5	19	639.6	19	56	25.147	25.112	25.166		Cloudy.		
	28	6 a. m		639.9	9	639.7	9	50	25.151	25.143	25.170		Rain; light southwest breeze.		
Camp 75, creek	28	7 p. m	1093.42	645.3	16	644.5	16	64	25.363	25.331		4641.9	Clear; light southeast breeze.		
	28	9 p. m		645.3	16	644.5	16	56	25.343	25.311			Do	do.	
	29	6 a. m		641.4	6.5	644.4	6.5	46	25.336	25.336	25.351		Do	do.	
	29	8 a. m		646.4	13	649.4	13	54	25.368	25.486	25.367		Do	do.	
											25.558				
	29	12 m	1100.52	651.2	23	649.4	23	74	25.558	25.448	25.448	4575.5	Do	do.	
Camp 76, water in holes in dry creeks.	29	4.30 p. m	1107.52	649.9	20	650.1	20	67	25.549	25.557		4168.7	Cloudy.		
	29	6 p. m		649.3	18	649.3	18	65	25.519	25.519			Do.		
	29	9 p. m		649.2	14.5	649	14.5	59	25.540	25.492			Do.		
	30	6 a. m		651.4	12.5	649.8	12.5	49	25.584	25.525	25.552		Do.		
	30	8 a. m		651.4	14	650.1	14	56	25.561	25.510	25.520		Do.		
											25.822				
On ridge	30	12 m	1115.51	658.5	19.5	656.8	19.5	67	25.822	25.755	25.755	4231.5	Do.		
Camp 77, Green river	30	3 p. m	1121.52	664.3	20	664.6	20	69	26.191	26.113		3973.3	Light clouds; light breeze from southeast.		
	30	4 p. m		664.2	20	663.7	20	67	26.112	26.089			Light clouds.		
	30	6 p. m		663.7	17	663.2	17	62	26.089	26.070			Do.		
	30	9 p. m		663.7	15	663.2	15	60	26.067	26.126			Do.		
Oct.	1	6 a. m		663.5	7	664.1	7	44	26.092	26.112	26.086		Clear.		
	1	8 a. m		664.5	14	665.6	14	58	26.073	26.116	26.102		Do.		
Camp 78, west bank of Green river.	1	12 m	1122.60	667.6	22	667.3	22	68	26.164	26.153		3828.3	Do.		
	1	3 p. m		666.8	26	665	26	80	26.172	26.101			Do.		

II.—*Barometric and Meteorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from Westport.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 78—Continued	Oct. 1	6 p. m		665.8	19	664.5	19	67	26.164	26.113			Clear.
	1	9 p. m		665.2	13.5	664.9	13.5	60	26.134	26.122	26.152		Do.
	2	6 a. m		664.5	6	665.9	6	37	26.131	26.186	26.136		Do.
											25.999		
Station on ridge	2	12 m	1130.81	663.6	24	663.2	24	79	25.999	25.983	25.983	4062	
Camp 79, Spanish trail, Akanaquint spring.	2	6 p. m	1139.35	650.9	24	651.3	24	72	25.558	25.574		4457	Do.
	2	9 p. m		649.9	10	650.4	10	55	25.548	25.567			Do.
	3	6 a. m		649.1	7	649.4	7	43	25.521	25.533	25.526		Do.
	3	8 a. m		650	17	649.8	17	54	25.490	25.482	25.542		Do.
											25.172		
Station, bed of creek	3	12 m	1143.95	642.5	25	643.8	25	92	25.172	25.224	25.224	5005.5	Do.
											25.090		
Leaving Spanish trail	3	1 p. m	1145.09	639.9	25	637	25	92	25.090	24.976	24.976	5194.5	
Camp 80, Dry creek	3	7 p. m	1155.13	642.7	16	643.9	16	65	25.265	25.312		4753.5	Do.
	3	9 p. m		642.3	14	642.5	14	60	25.233	25.241	25.256		Do.
	4	6 a. m		642.9	7	640.9	7	38	25.277	25.198	25.249		Do.
Leaving Dry creek	4	10.30 a. m	1159.92	648.6	22	648	22	82	25.395	25.372		4747.5	Do.
Station near White river	4	12 m	1162.02	651.1	25	648.5	25	83	25.511	25.408		4667.3	
Camp 81, White river	4	3 p. m	1164.95	648.9	29	648.9	29	81	25.460	25.460		4592.5	Clear; light breeze from north.
	4	6 p. m		647.4	21	646.3	21	69	25.440	25.397			Do do.
	4	9 p. m		647.3	15	647.3	15	59	25.426	25.426	25.435		Do do.
	5	6 a. m		646.6	7	647.7	7	38	25.423	25.466	25.435		Do do.
Camp 82, Clever creek	5	3 p. m	1173.65	640.2	26.5	640.4	26.5	78	25.133	25.141		4957.8	Light clouds; light southeast wind.
	5	6 p. m		639.9	23	639.9	23	77	25.137	25.137			Do do.
	5	9 p. m		638.4	14	638.1	14	60	25.079	25.067	25.104		Do do.
	6	6 a. m		637.5	6	638.2	5	34	25.072	25.100	25.108		Do do.
											24.899		
Leaving Clever creek	6	11 a. m	1178.15	635.2	19.5	633.7	19.5	64	24.899	24.835	24.835	5221.2	Do do.
Noon halt	6	12 m	1180.67	632	23.5	630	23.5	73	24.771	24.692		5436	
Camp 83, hill overlooking White river.	6	4.30 p. m	1184.77	632.3	25	633	25	77	24.849	24.876		5213.4	Clear; light breeze from northeast.
	6	6 p. m		632.1	21	631.6	21	69	24.838	24.818			Do do.
	6	9 p. m		631.5	13	632.5	13	56	24.815	24.855	24.825		Do do.
	7	6 a. m		630.7	5	632.7	5	31	24.804	24.883	24.856		Do do.
											24.696		
Station	7	12 m	1191.35	630.2	25.5	628.6	25.5	82	24.696	24.633	24.633	5564	Do do.
Camp 84, Standing Water creek.	7	6 p. m	1198.03	620.8	23	619.9	23	75	24.389	24.353		5718.7	Cloudy.
	7	9 p. m		620.7	11	620.7	11	51	24.394	24.394	24.382		Do.
	8	6 a. m		619.7	5	620	5	34	24.371	24.383	24.375		Do.
											24.534		

Station near San Rafael, first branch.	8	12 m	1205.75	626.2	26	624	26.0	74	24.534	24.444	24.444	5718.4	
Camp 85, San Rafael, second branch.	8	6 p. m	1211.23	629.3	24	626.6	24	77	24.719	24.613	.....	5428.9	Light clouds.
	8	9 p. m	.....	635.4	14	635.3	14	58	24.973	24.969	.....	.....	Do.
	9	6 a. m	.....	626.5	4	626	4	26	24.643	24.623	.....	.....	Clear.
	9	9 a. m	.....	627.4	13	626.8	13	44	24.614	24.590	.....	.....	Do.
	9	12 m	.....	628.7	24	627.4	24	66	24.641	24.590	.....	.....	Cloudy; light northeast breeze.
	9	3 p. m	.....	627.7	22	625.5	22	73	24.660	24.574	.....	.....	Cloudy.
	9	6 p. m	.....	626.3	17	624.9	17	59	24.633	24.578	.....	.....	Do.
	9	9 p. m	.....	626.3	14	624.9	14	50	24.607	24.552	24.675	.....	Do.
	10	6 a. m	.....	625.7	12	626.7	12	50	24.580	24.619	24.631	.....	Do.
											24.436		
Spanish trail	10	12 m	1218.85	623.6	25	621.6	25	76	24.436	24.357	24.357	5837.5	
Camp 86, Garambulla river.	10	3.30 p. m	1222.63	620.8	24	619.3	24	74	24.390	24.331	.....	5728.8	Clear; light breeze from southwest.
		6 p. m	.....	620.5	18	620	18	60	24.401	24.381	.....	.....	Do do.
		9 p. m	.....	620.5	11	620	11	48	24.386	24.367	24.386	.....	Do do.
	11	6 a. m	.....	619.4	3	621.2	3	32	24.367	24.438	24.378	.....	Do do.
											24.027		
Dividing ridge	11	12 m	1230.48	613.1	24.5	612.1	24.5	69	24.027	23.987	23.987	6246.1	Clear.
Camp 87, Big Rock creek	11	3.30 p. m.	1236.09	616.4	22.5	614	22.5	74	24.224	24.130	.....	5957.8	Do.
	11	6 p. m	.....	615.7	17	613.2	17	61	24.215	24.117	.....	.....	Do.
	11	9 p. m	.....	614.8	6	612.9	6	45	24.182	24.107	24.193	.....	Do.
	12	6 a. m	.....	613.5	0	612	0	21	24.147	24.088	24.110	.....	Do.
Noon halt	12	11.45 a. m	.....	617.3	24	615.9	24	74	24.168	24.113	24.178	.....	Do.
Crossing of stream	12	12 m	1243.30	617	21	615.6	24	70	24.188	24.133	24.123	6098.2	
Camp 88, Oak springs	12	6 p. m	1251.74	597.1	17	597.9	17	62	23.484	23.515	.....	6789.7	Dark clouds; light northwest wind.
	12	9 p. m	.....	596.9	16	598.1	16	58	23.446	23.493	.....	.....	Do do.
	13	6 a. m	.....	596.2	9	595.8	9	48	23.431	23.415	23.444	.....	Do do.
	13	8 a. m	.....	596.6	9	597.2	9	50	23.424	23.447	23.467	.....	Cloudy; strong northwest wind.
	13	10 a. m	.....	.....	.....	595.8	12	50	.....	23.360			
Summit of Wahsatch Pass	13	2.15 & 1.15 p. m.	1258.39	574.5	14.7	574.4	9	58&48	22.619	22.615	.....	7820	
Camp 89, Salt creek—western slope of Wahsatch mountains.	13	5 p. m	1262.96	.....	.....	591	13	50	.....	23.271	.....	6976.6	
	13	6 p. m	.....	590.2	14	589.5	14	47	23.229	23.192	.....	.....	Cloudy.
	13	9 p. m	.....	590.5	11	590.9	11	38	23.205	23.221	23.205	.....	Do.
	14	6 a. m	.....	590.1	7	590.7	7	35	23.198	23.222	23.213	.....	Do.
Camp 90, Swambah creek	14	6 p. m	1267.96	577.1	8	576.7	8	47	22.720	22.704	.....	7623.1	Clear.
	14	9 p. m	.....	582.7	11	577	11	53	22.899	22.674	.....	.....	Do.
	15	6 a. m	.....	575.5	2	576.9	2	35	22.643	22.696	22.730	.....	Do.
	15	8.30 a. m	.....	577.7	12	577.3	12	48	22.663	22.644	22.679	.....	Do.
Camp 91, Ungottahbikin creek.	15	5 p. m	1276 46	.....	.....	602	15	56	.....	23.692	.....	6551.2	Light clouds.
	15	6 p. m	.....	602	13	602.1	13	55	23.680	23.684	.....	.....	Do.
	15	9 p. m	.....	602	10	603	10	53	23.663	23.701	.....	.....	Clear.
	16	6 a. m	.....	602.7	8	603	8	48	23.686	23.698	.....	.....	Do.
	16	9 a. m	.....	603	18	603.2	19	65	23.630	23.638	.....	.....	Do.
	16	12 m	.....	603.7	20	603.2	20	69	23.660	23.641	.....	.....	Do.
	16	3 p. m	.....	603.7	21	603.2	21	70	23.712	23.771	.....	.....	Do.
	16	6 p. m	.....	602.8	16	602.8	16	65	23.700	23.700	.....	.....	Do.
	16	9 p. m	.....	599.2	9	603.1	9	49	23.556	23.709	23.659	.....	Do.
	17	6 a. m	.....	601.8	7	603.2	7	44	23.659	23.714	23.694	.....	Do.
Camp 92, Sevier river	17	5.30 p. m	1290.71	.....	.....	636.1	22	69	.....	24.998	.....	5019.1	Clear; light breeze from northwest.
	17	6.30 p. m	.....	637.3	16	636.1	16	60	25.053	25.006	.....	.....	Do do.
	17	9 p. m	.....	636.8	10	636.6	10	54	25.032	25.024	.....	.....	Do do.

II.—*Barometric and Meteorological Observations and Data for Profile*—Continued.

Station.	Day.	Hour.	Distance from Westport.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
	1853.		*Miles.*						*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 92—Continued.....	Oct. 18	6 a. m.....	.....	635.9	2	636.3	2	33	25.021	25.037	.....	.....	Clear; light breeze from northwest.
	18	8 a. m.....	.....	637.4	15	636.6	15	63	25.006	24.974	25.018	.....	Do do.
	18	9 a. m.....	.....	637.4	16	636.6	16	63	24.992	24.960	25.002	.....	Do do.
Camp 93, San Pete creek...	18	6 p. m.....	1302.53	637.7	19	637.5	19	60	25.062	25.054	.....	4960.5	Clear.
	18	9 p. m.....	.....	636.5	12	637	12	58	25.012	25.032	25.032	.....	Do.
	19	6 a. m.....	.....	635.8	1	637.5	1	34	25.021	25.088	25.056	.....	Do.
											25.066		
Station above Sevier river..	19	12 m.....	1312.62	639.7	23	637.2	23	76	25.066	24.968	24.968	5128.3	
Camp 94, Sevier river.....	19	6 p. m.....	1321.63	640.6	18	639.9	18	65	25.180	25.152	.....	4869.1	Broken clouds.
	19	9 p. m.....	.....	639	15	637.8	15	64	25.099	25.052	25.158	.....	Cloudy.
	20	6 a. m.....	.....	640.4	1	640.2	1	32	25.202	25.194	25.134	.....	Do.
Camp 95, on north bend of Sevier river, one mile above bridge.	20	9.30 a. m...	1324.08	642.2	19	641.6	19	61	25.164	25.140	.....	4782.7	Do.
	20	12 m.....	.....	642.2	20	641.6	20	69	25.176	25.152	.....	.....	Do.
	20	3 p. m.....	.....	641.9	21	640.7	21	70	25.215	25.168	.....	.....	Do.
	20	6 p. m.....	.....	642.5	17	642.2	17	60	25.259	25.247	.....	.....	Do.
	20	9 p. m.....	.....	642.5	7	642.2	7	47	25.268	25.256	25.222	.....	Do.
	21	6 a. m.....	.....	640.8	— 6	642.3	— 6	20	25.245	25.304	25.210	.....	Do.
Summit of ridge north of Lake valley.	21	11 a. m.....	1328.57	631.1	15	629.4	15	56	24.733	24.666	.....	5376.1	
In Lake valley.....	.....	12 m.....	1335.96	633.8	17	632.9	17	60	24.861	24.826	.....	5237.5	
Summit of ridge south of Lake valley.	.....	3 p. m.....	1339.48	616.9	13	615.5	13	52	24.267	24.212	.....	5871.2	
Camp 96, Cedar Springs....	21	6.30 p. m...	1348.28	633.9	13	632.8	13	54	24.931	24.883	.....	5131.1	Light floating clouds.
	21	9 p. m.....	.....	632.7	11	632.5	11	57	24.867	24.859	.....	.....	Do.
	22	6 a. m.....	.....	632.6	7	630.8	7	40	24.871	24.801	.....	.....	Do.
	22	9 a. m.....	.....	632.8	8	631.9	8	52	24.842	24.807	.....	.....	Do.
	22	12 m.....	.....	631.7	9	632.6	9	59	24.810	24.845	.....	.....	Do.
	22	3 p. m.....	.....	632	6	632.9	6	45	24.889	24.924	.....	.....	Do.
	22	6 p. m.....	.....	632	6	632.9	6	45	24.889	24.924	.....	.....	Do.
	22	9 p. m.....	.....	632	6	632.4	6	44	24.859	24.874	.....	.....	Do.
	23	6 a. m.....	.....	631.8	— 8	632.2	— 8	15	24.899	24.915	.....	.....	Do.
	23	9 a. m.....	.....	634.5	10	633.8	10	49	24.901	24.874	24.873	.....	Do.
	23	12 m.....	.....	632.9	10	631.6	10	52	24.853	24.802	24.865	.....	Do.
Camp 98, Sevier river.....	24	12 m.....	1373.71	645	14	649.9	14	52	25.314	25.507	.....	4692.7	Clear: light breeze from southwest.
	24	3 p. m.....	.....	642.2	21	647	21	71	25.227	25.416	.....	.....	Do do.
	24	6 p. m.....	.....	637.5	12	641.2	12	56	25.082	25.227	.....	.....	Light clouds.
	24	9 p. m.....	.....	637.5	12	645.2	12	20	25.052	25.355	25.176	.....	Dark clouds; snow fell during the night.
	25	6 a. m.....	.....	641	3	641.6	3	20	25.218	25.242	25.349	.....	Snow in mountains.

Camp 102, Pioneer creek...		30	6 a. m.....	1419.80	639	0	639.3	0	20	25.151	25.163	.....	4921.6	Not used in profile.
		30	9 a. m.....	.....	640.3	14	639.2	14	58	25.114	25.071	.....	.....	Clear.
		30	12 m.....	.....	640.2	19	637.6	19	66	25.105	25.003	.....	.....	Do.
		30	3 p. m.....	.....	640.2	20	637.6	20	66	25.152	25.050	25.128	.....	Do.
		30	6 p. m.....	.....	638.5	12	634.2	12	49	25.121	24.952	25.050	.....	Do.
Camp 103, Sevier river, near former camp 95.	Nov.	1	6 a. m.....	1448.04	634.3	— 2	633.3	— 2	18	24.974	24.934	24.974	4887.5	
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.934		
Camp 104, Nephi		2	6 a. m.....	1472.89	636.7	—10	636	—10	15	25.100	25.072	.....	4938.4	Clear; light northwest breeze.
		2	9 a. m.....	.....	638	8	636.1	8	44	25.047	24.972	.....	.....	Clear.
		2	12 m.....	.....	637.6	15	636.3	15	56	25.019	24.968	.....	.....	Do.
		2	3 p. m.....	.....	636.9	17	635.4	17	56	25.038	24.979	.....	.....	Do.
		2	6 p. m.....	.....	635.5	5	634.6	5	38	25.030	24.995	25.033	.....	Do.
		3	6 a. m.....	.....	634.1	— 1	633.6	— 1	28	24.962	24.942	24.990	.....	Do.
Camp 105, Payson		3	6 p. m.....	1498.07	646.9	9	646.7	9	49	25.463	25.456	.....	4540.7	Do.
		3	9 p. m.....	.....	646.5	7	646.3	7	42	25.426	25.418	25.371	.....	Do.
		4	6 a. m.....	.....	640.7	— 1	641.7	— 1	24	25.222	25.261	25.379	.....	Do.
Camp 106, Provo.....		4	6 p. m.....	1517.30	650.3	18	649.8	18	56	25.562	25.503	.....	4362.6	Do.
		4	9 p. m.....	.....	649.8		649.6	9	42	25.548	25.540	25.556	.....	Do.
		5	6 a. m.....	.....	649.5	0	651	0	26	25.564	25.623	25.556	.....	Light clouds.
Camp 107, American Fork..		5	3 p. m.....	1531.30	647.5	19	647	19	68	25.448	25.428	.....	4596.1	Light clouds; light breeze from northwest.
		5	6 p. m.....	.....	646	12	644.4	12	52	25.416	25.353	.....	.....	Light clouds.
		5	9 p. m.....	.....	646	9	644.4	9	48	25.398	25.335	25.411	.....	Do.
		6	6 a. m.....	.....	645.7	6	644.6	6	42	25.391	25.348	25.364	.....	Do.
Camp 108, Willow creek ...		6	3 p. m.....	1546.70	643.9	16	642.9	16	56	25.318	25.279	.....	4733.4	Cloudy; strong northwest wind.
		6	6 p. m.....	.....	642.8	12	642	12	52	25.290	25.259	.....	.....	Cloudy.
		6	9 p. m.....	.....	642.8	12	642	12	50	25.260	25.229	25.277	.....	Do.
		7	6 a. m.....	.....	642.6	11	642	11	50	25.249	25.226	25.246	.....	Do.
Camp 109, Cottonwood, near Great Salt Lake City.		7	3 p. m.....	1558.15	650.6	5	650.7	5	39	25.625	25.629	.....	4241.1	Cloudy; strong northwest wind.
		7	6 p. m.....	.....	650.5	3	651.3	3	36	25.629	25.660	.....	.....	Do do.
		7	9 p. m.....	.....	650.8	2	651.6	2	30	25.614	25.646	25.620	.....	Clear; light northwest wind; snow-storm at night.
		8	6 a. m.....	.....	650.8	0	651.6	0	25	25.662	25.647	25.643	.....	Do do.
Great Salt Lake City	.....	.....	.....	1567.95	.....	.....	.....	.....	.....	.....	.....	.....	4351.0	Altitude determined from all the observations taken at this place, from November, 1853, to May, 1854. Tables will accompany subsequent report.

III.—*Data for Profile of Roubideau's Pass—Altitudes above Camp* 46, (*Creek.*)

Station.	Hour.	Barometer, in inches, No. 496.	Attached ther., (F.)	Corrected barometer, in inches.	Det'd thermometer.	Height above camp 46.	Entire altitude.	Dist from camp 46.
						Feet.	*Feet.*	*Miles.*
Camp 46							7638	
Level of base of mountain	3.30 p. m.	22.496	85.1	22.420	73	517.86	8155.9	6.25
Outlet of pass	2.30 p. m.	22.390	82.4	22.225	76	968.12	8606.1	7.85
Two miles from summit	10.40 a. m.	21.855	59.9	21.764	65			
Two miles from summit	2 p. m.	21.855	64.4	21.778	62.5	1341.00	8979.1	9.10
One mile from summit	1.30 p. m.	21.551	84.2	21.449	72	1718.15	9356.1	9.80
Summit station	12½ p. m.	21.272	78.8	21.163	62	2134.11	9772.1	10.55

IV.—*Simultaneous Meteorological Observations at the Coochetopa Pass.*

		ADVANCE PARTY.						REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, in inches.	Attached thermometer, (F.)	Station.	Hour.	Barometer, No. 551.	Attached thermometer, (C.)	Barometer, in inches.	Attached thermometer, (F.)
Sept. 2	9 a. m.	Station 1	536	20*	21.890	68						
	10 a. m.	Station 2	550.5	22.5	21.634	72.5	Station 1	10 a. m.	555.6	22	21.874	71.6
	11 a. m.	Station 3	544.7	24.5	21.445	76.1	Station 2	11 a. m.	550.3	23	21.666	73.4
	12 m.	Station 4	539.2	20	21.229	68	Station 3	12 m.	544.1	25	21.421	77
	1 p. m.	Summit	532.4	17	20.961	62.6	Station 4	1 p. m.	540	23	21.260	73.4
	1.30 p. m.	do	532.3	15	20.957	59	Summit	1.30 p. m.	532.9	15	20.981	59
							Do	2 p. m.	532.8	13	20.977	55.4

V.—*Observations for a Deep Cut or Tunnel, allowing fifty yards as width of the ridge, in the Coochetopa Pass.*

Sept. 2	12.45 p. m	Summit	532.4	17*	20.961	62.6						
	1 p. m.	*350 ft. east	534.4	17.5	21.240	63.5						
	1.15 p. m.	Summit	532.8	17.5	20.965	63.5						
	1.20 p. m.	*350 ft. west	533	16.5	20.985	61.7						
	1.30 p. m.	Summit	532.3	15.5	20.957	59.9						

* Besides 150 feet, the width of ridge at summit level.

IV.—*Simultaneous Meteorological Observations at the Coochetopa Pass*—Continued.

Sept. 3	6 a. m.	Camp 54	541.4	11*	21.316	51.8	Camp 54	6 a. m.	540.7	11	21.288	51.8
	8 a. m.	Station 1	547.4	21	21.552	69.8	Do	8 a. m.	541.5	18	21.320	64.4
	9 a. m.	Station 2	550.3	23.7	21.666	74.6	Station 1	9 a. m.	546.8	23	21.528	73.4
	10 a. m.	Station 3	554	25	21.811	77	Station 2	10 a. m.	549	23	21.614	73.4
	11 a. m.	Station 4	556.4	22.2	21.906	71.9	Station 3	11 a. m.	553.5	25	21.792	77
	1 p. m.	Station 5	554.1	25	21.815	77	Station 4	1 p. m.	560	24	22.048	75.2
	2 p. m.	Station 6	548	22.8	21.575	73	Station 5	2 p. m.	554.1	26	21.815	78.8
	3 p. m.	Station 7	555.4	26	21.867	77	Station 6	3 p. m.	545.8	25	21.489	77
	4 p. m.	Station 8	559	25.5	22.009	77.9	Station 7	4 p. m.	554.5	24	21.831	75.2
	5 p. m.	Camp 55	564.4	27	22.221	80.6	Station 8	5 p. m.	557.5	24	21.950	75.2
	6 p. m.	do	564.4	24	22.221	75.2	Camp 55	6 p. m.	564.2	23.5	22.213	74.3
	9 p. m.	do	562.2	13	22.134	55.4	Do	9 p. m.	562.5	13	22.146	55.4

* For air temperature, at corresponding hours, see Table VI.

VI.—*Data for Profile of the Coochetopa Pass.*

Date.	Hour.	Station.	Corrected barometer, 496.	Air thermometer.	Station.	Corrected barometer, 551.	Air thermometer.	Difference of altitudes.	Entire altitude	Intermediate distance.	Entire distance.
1853.				°			°	*Feet.*	*Feet.*	*Miles.*	(*Miles from camp* 53.)
Sept. 2	9 a. m ...	Station 1...	21.812	70*	Camp 53...	21.682†	84*	— 62	8898		
	10 a. m ..	Station 2...	21.550	66	Station 1...	21.790	65	312	9210	1.62	1.62
	11 a. m ..	Station 3...	21.354	71	Station 2...	21.581	68	300	9510	1.39	3.01
	12 m	Station 4...	21.154	60	Station 3...	21.328	65	230.3	9740.3	.58	3.59
	1 p. m...	Station 5, summit.	20.897	64	Station 4...	21.174	64	291.7‡	10032	.24	3.83
	1.30 p. m.	Station 5, summit.	20.900	59	Station 5, summit.	20.924	59				
					Station 5, summit.	20.936	58				
	Means at.	Camp 54...	21.289	61	Camp 54...	21.281	61	—492	9540	1.33	5.16

VI.—*Declivities near summit.*

Sept. 2	12.45 p. m	Summit....	20.897	64§							
	1 p. m...	Station east.	20.974	59	.....	.....	.....	—102.3	.....	350 ft. east of summit.	.....
	1.15 p. m.	Summit....	20.899	59							
	1.20 p. m.	Station west.	20.962	58	.....	.....	.....	— 82.5	.....	350 ft. west of summit.	.....
	1.30 p. m.	Summit....	20.898	58							

VI.—*Data for Profile of the Coochetopa Pass*—Continued.

1853.				°			°	*Feet.*	*Feet.*	*Miles.*	(*Miles from camp* 54.)
Sept. 3	6 a. m ...	Camp 54...	21.271	55*	Camp 54...	21.244	55*	.....	9540		
	8 a. m ...	Station 1...	21.472	59	....do.....	21.271	58	—243	9297	2.24	2.24
	9 a. m ...	Station 2...	21.578	66	Station 1...	21.412	64	—147	9150	2.15	4.39
	10 a. m ..	Station 3...	21.716	70	Station 2...	21.582	69	—191	8959	2.05	6.44
	11 a. m ..	Station 4...	21.821	68	Station 3...	21.697	74	—144	8815	3.47	9.91
	1 p. m...	Station 5...	21.720	66	Station 4...	21.957	73	195	9010	1.28	11.19
	2 p. m...	Station 6...	21.490	71	Station 5...	21.716	76	232	9342	1.74	12.93
	3 p. m...	Station 7...	21.772	74	Station 6...	21.396	72	—353	8989	2.14	15.07
	4 p. m...	Station 8...	21.912	74	Station 7...	21.740	75	—277	8712	2.20	17.27
	5 p. m...	Camp 55...	22.118	74	Station 8...	21.859	73				
	6 p. m...	....do.....	22.130	68	Camp 55...	22.123	68	—197	8515	2.73	20
	9 p. m...	....do.....	22.082	59	....do.....	22.094	59				

* For instrument temperatures, at corresponding hours, see Table IV.

† Station 1 compared with camp 53 and corrected.

‡ The altitude of station 5, at summit, determined by comparison of all the observations made there with the mean at camp 54.

§ For instrument temperatures, at corresponding hours, see Table V.

VII.—*Simultaneous Meteorological Observations at the pass and on the route followed across the Wahsatch range.—Camp 88 to Camp 89.*

	ADVANCE PARTY.						REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 551.	Attached ther. (C.)	Barometer, in inches.	Attached ther. (F.)	Station.	Hour.	Barometer, No. 496.	Attached ther. (C.)	Barometer, in inches.	Attached ther. (F.)
Oct. 13	8 a. m ...	Camp 88...	597.2	9*	23.512	48.2						
	9 a. m ...	Station 1...	595.8	12	23.456	53.6	Camp 88...	9 a. m ...	598.4	9.8*	23.560	49.6
	10 a. m ..	Station 2...	594.1	11	23.390	51.8	Station 1...	10 a. m ..	595.2	11.7	23.432	53
	11 a. m ..	Station 3...	589.7	11	23.217	51.8	Station 2...	11 a. m ..	594.3	11.4	23.398	52.5
	12 m.....	Station 4...	584.1	11	22.997	51.8	Station 3...	12 m.....	588.6	10.3	23.174	50.5
	1 p. m ...	Station 5...	577.1	11	22.721	51.8	Station 4...	1 p. m ...	582.9	12.3	22.952	54.1
	1.15 p. m.	Summit	574.4	9	22.615	48.2						
	2 p. m ...	Station 6...	583.1	12.5	22.957	54.5	Station 5 ...	2 p. m ...	575.5	13.1	22.658	55.6
							Summit	2.15 p. m.	574.5	14.7	22.619	58.4
	3 p. m ...	Station 7...	587.2	12	23.119	53.6	Station 6 ...	3 p. m ...	582.3	12.7	22.926	54.8
	4 p. m ...	Camp 89...	591	13	23.268	55.4	Station 7 ...	4 p. m ...	586.9	13	23.107	55.4
	5 p. m ...	....do.....	589.9	14	23.225	57.2	Camp 89 ...	5 p. m ...	590.2	13	23.237	55.4

VII.—*Simultaneous Meteorological Observations at the pass and on the route followed across the Wahsatch range.—Camp 89 to Camp 90.*

Oct. 14	6 a. m ...	Camp 89...	590.7	7*	23.257	44.6						
	9 a. m ...	Station 1...	592.2	8	23.316	46.4	Camp 89 ...	9 a. m ...	591.4	8*	23.284	46.4
	10 a. m ..	Station 2...	591.4	14	23.284	57.2	Station 1 ...	10 a. m ..	592.2	15	23.316	59
	11 a. m ..	Station 3...	584.1	21	22.997	69.8	Station 2 ...	11 a. m ..	590.6	16.3	23.253	61.34
	12 m.....	Station 4...	585.7	21	23.060	69.8	Station 3 ...	12 m.....	584.1	21	22.997	69.8
	1 p. m ...	Station 5...	584.1	21	22.997	69.8	Station 4 ...	1 p. m ...	585.9	24.5	23.068	76.1
	2 p. m ...	Station 6...	584.8	20	23.025	68	Station 5 ...	2 p. m ...	583.8	25.4	22.985	77.72
	3 p. m ...	Station 7...	582.3	20	22.926	68	Station 6 ...	3 p. m ...	582.3	20	22.926	68
	4 p. m ...	Station 8...	581	20	22.875	68	Station 7 ...	4 p. m ...	581	20	22.875	68
	5 p. m ...	Camp 90...	576.7	8	22.706	46.4	Station 8 ...	5 p. m ...	576.7	8	22.706	46.4
	6 p. m ...	....do.....	576.7	8	22.706	46.4						

VII.—*Simultaneous Meteorological Observations at the pass and on the route followed across the Wahsatch range.—Camp 90 to Camp 91.*

Oct. 15	8.30 a. m.	Camp 90...	577.3	12*	22.729	53.6						
	9 a. m ...	Station 1...	577	14	22.717	57.2	Camp 90† ..	8.30 a. m.	577.3	12*	22.729	53.6
	10 a. m ..	Station 2...	570.6	20	22.465	68	Station 1 ...	9 a. m ...	577	14	22.717	57.2
	11 a. m ..	Station 3...	566.7	20	22.312	68	Station 2 ...	10 a. m ..	570.6	20	22.465	68
	11.45 a. m	Station 4...	556.3	18	21.903	64.4	Station 3 ...	11 a. m ..	566.7	20	22.312	68
	1 p. m ...	Station 5. .	569.8	19	22.434	66.2	Station 4 ...	1 p. m ...	555.6	22.6	21.875	72.7
	2 p. m ...	Station 6...	579	20	22.796	68	Station 5 ...	2 p. m ...	568.8	17.9	22.395	64.2
	3 p. m ...	Station 7...	587.4	20	23.127	68	Station 6 ...	3 p. m ...	577.2	17	22.725	62.6
	4 p. m ...	Station 8...	590.7	19	23.257	66.2	Station 7 ...	4 p. m ...	586.6	20.4	23.107	68.7
	5 p. m ...	Camp 91...	602	15	23.701	59	Station 8 ...	5 p. m ...	590.3	20.3	23.241	68.5
	6 p. m ...	....do.....	602.1	15	23.705	59						

* For air temperatures, at corresponding hours, see Tables VIII.

† The first four observations recorded for the rear party are taken from barometer No. 551, as observed the previous hour.

VIII.—*Data for Profile of the pass and the route followed across the Wahsatch range.—Camp* 88 *to Camp* 89.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air thermometer, (F.)	Station.	Corrected barometer, No. 496.	Air thermometer, (F.)	Difference of altitudes.	Entire altitude above camp 88.	Intermedinte distance.	Distance from camp 88.
										Miles.	*Miles.*
Oct. 13	8 a. m.....	Camp 88.....	23.471	50*							
	9 a. m.....	Station 1.....	23.403	46	Camp 88.....	23.516	48*	129.7	129.7	.61	.61
	10 a. m.....	Station 2.....	23.342	50	Station 1.....	23.380	49	43.9	173.6	1.08	1.69
	11 a. m.....	Station 3.....	23.169	50	Station 2.....	23.348	48	231.9	405.5	1.66	3.35
	12 m.....	Station 4.....	22.949	50	Station 3.....	23.130	50	250.2	655.7	1.34	4.69
	1 p. m	Station 5.....	22.674	49	Station 4.....	22.898	49	327.1	982.8	1.74	6.43
	1.15 p. m...	Summit.....	22.576	47	.....	.....	.....	48.9	1031.7	.22	6.65
	2 p. m.....	Station 6.....	22.904	54	Station 5.....	22.605	49	—359.8†	623	1.90	8.55
	2.15 p. m...	.....	.....	.....	Summit.....	22.559	50	—415.6	616.1	.....	.....
	3 p. m.....	Station 7.....	23.067	50	Station 6.....	22.871	52	—232.8	383.3	1.70	10.25
	4 p. m.....	Camp 89.....	23.212	50	Station 7.....	23.051	49	—190.1	193.2	.97	11.22
	5 p. m.....	....do.....	23.180	47.0	Camp 89.....	23.193	47	.....	.....	.....	.....

VIII.—*Data for Profile of the pass and the route followed across the Wahsatch range.—Camp* 89 *to Camp* 90.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air thermometer, (F.)	Station.	Corrected barometer, No. 496.	Air thermometer, (F.)	Difference of altitudes.	Entire altitude above camp 89.	Intermediate distance.	Distance from camp 89.
										Miles.	*Miles.*
Oct. 14	6 a. m.....	Camp 89.....	23.244	35*							
	9 a. m.....	Station 1.....	23.275	48	Camp 89.....	23.254	43*	— 24.9	— 24.9	.84	.84
	10 a. m.....	Station 2.....	23.226	56	Station 1.....	23.273	49	+ 56.2	+313	1.25	2.09
	11 a. m.....	Station 3.....	22.934	59	Station 2.....	23.192	58	+310.7	+342	.99	3.08
	12 m.....	Station 4.....	22.995	60	Station 3.....	22.934	60	— 51	291	.60	3.68
	1 p. m.....	Station 5.....	22.928	62	Station 4.....	23.007	58	+ 95.5	386.5	.31	3.99
	2 p. m.....	Station 6.....	22.960	60	Station 5.....	22.918	61	— 50.1	336.4	.11	4.10
	3 p. m.....	Station 7.....	22.861	60	Station 6.....	22.960‡	60	+ 95.5	431.9	.20	4.30
	4 p. m	Station 8.....	22.814	58	Station 7.....	22.861	60	+ 56.9	488.8	.12	4.42
	5 p. m.....	Camp 90.....	22.669	47	Station 8.....	22.814	58	+174.9	663.7	.58	5
	6 p. m.....	....do.....	22.669	47							

* For temperature of instrument at corresponding hours, see Tables VII.

† The next determination is used for the difference between stations 5 and 6—in effect using the previous barometric reading at station 5, instead of that of barometer No. 496. From station 2 to the summit the successive readings of barometer 496 are used, with a horary correction—those of No. 551 being in error. The summit not being a station, the first barometer arriving there at 1*h*. 15*m*. p. m. had no corresponding observation of the second barometer; at 2 p. m. the observations were simultaneous on opposite sides of the summit; at 2*h*. 15*m* p. m. the second barometer, at the summit, was alone observed.

‡ The three following observations are taken from the readings of barometer 551 at the previous hours.

VIII.—*Data for Profile of the pass and the route followed across the Wahsatch range.—Camp* 90 *to Camp* 91.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air thermometer, (F.)	Station.	Corrected barometer, No. 496.	Air thermometer, (F.)	Difference of altitudes.	Entire altitude above camp 90.	Intermediate distance.	Distance from camp 90.
										Miles.	*Miles.*
Oct. 15	8.30 a. m...	Camp 90.....	22.690	48*							
	9 a. m.....	Station 1.....	22.676	49	Camp 90†.....	22.690	58*	28.8	28.8	.33	.33
	10 a. m.....	Station 2.....	22.404	59	Station 1.....	22.676	49	355.9	384.7	.54	.87
	11 a. m.....	Station 3.....	22.225	72	Station 2.....	22.404	59	251.7	636.4	.16	1.03
	11.45 a. m..	Station 4.....	21.828	66	Station 3.....	22.225	72	485.5	1121.9	.60	1.63
	1 p. m.....	Station 5.....	22.357	67	Station 4.....	21.807	63	—700.4	421.5	2.24	3.87
	2 p. m.....	Station 6.....	22.709	71	Station 5.....	22.330	61	—475.3	— 53.8	.78	4.65
	3 p. m.....	Station 7.....	23.052	65	Station 6.....	22.685	60	—449.3	— 503.1	1.60	6.25
	4 p. m.....	Station 8.....	23.186	63	Station 7.....	23.040	61	—176.4	— 679.5	.50	6.75
	5 p. m.....	Camp 91.....	23.643	56	Station 8.....	23.174	61	—556.2	—1235.7	1.75	8.50
	6 p. m.....	....do.....	23.649	55							

* See Tables VII for temperature of instruments at corresponding hours.

† The first four observations entered, as at the rear stations, are taken from the readings of barometer 551 the previous hours.

CHAPTER X.

Geographical Positions, and Distances travelled, on the line of exploration from Westport, Mo., to Great Salt Lake City. 1853.

I.—Letter from Mr. S. Homans, in charge of astronomical department.
II.—Table of geographical positions from Westport, Missouri, to Great Salt Lake City, Utah.
III.—Table of distances travelled, including those from point to point at which barometrical observations were made, on the route from Westport, Missouri, to Great Salt Lake City.
IV.—Table of distances travelled on the line followed from Westport, Missouri, via Fort Riley, Kansas Territory, to Walnut creek.

I.—*Letter from Mr. S. Homans, in charge of Astronomical Department.*

SIR: In the following table of geographical positions the latitudes only are given. Lunar distances and culminations were also observed; but, from imperfections in the instruments, the results were deemed useless. The selection of astronomical instruments for this expedition was most unfortunate; they have all proved defective, and some entirely unfit for use.

In the duty of constructing the map, which devolved upon me by the death of Mr. Richard H. Kern, I have adopted the method of "course and distance," corrected by latitudes found by meridional observations, as being more reliable than the chronometric determinations. The accuracy of positions on the map, referred to the assumed longitudes, attests the fidelity and skill of the topographical notes and sketches by that gentleman.

I am, very respectfully,

SHEPPARD HOMANS,
In Charge of Astronomical Department.

Lieut. E. G. BECKWITH,
United States Army, Commanding Expedition.

II.—*Geographical Positions from Westport to Sult Lake City.*

Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
1853.			° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″
June 16	Camp near Westport	Polaris		1 40.5			39 01 34
23	Indian creek	do		1 49.2			38 55 56
24	Cedar creek	do		2 15			38 52 41
26	Wahkarrussi ferry	do		2 15			38 55 15
27	Prairie spring	do		2 10			39 00 38
July 1	Near Kansas river	do		2 10			39 04 29
3	Opposite Fort Riley	do		2 10			39 03 19
5		do		2 10			38 59 30
6	Solomon's fork	do		2 05			38 55 29
7	Saline fork	do		2 05			38 53 03
8		do		2 05			38 44 51
9							38 37 38
11	Cow creek	Antares	—26 06 11	1 45	50 42 45	25 20 20	38 33 29
12	Walnut creek	do	—26 06 11	1 45	51 03 40	25 30 54	38 22 55
13	Pawnee fork	Jupiter	—22 15 25	1 45	59 08 30	29 33 32	38 11 03
15	Coon creek	Antares	—26 06 11	1 45	52 11 30	26 04 49	37 49 00

II.—*Geographical Positions*—Continued.

Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
1853.			° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″
July 21	Arkansas river	Jupiter	—22 13 15	1 43.5	59 39 40	29 49 11	37 57 34
23	do	Antares	—26 06 11	1 43.5	51 45 35	25 51 54	38 01 56
26	do	do	—26 06 11	1 43.5	51 22 50	25 40 31	38 13 18
27	do noon halt	Sun	19 08 10	1 40	141 27 10	70 59 57	38 08 13
28	do	do	18 54 19	1 40	141 09 00	70 50 52	38 03 27
30	do noon halt	do	18 25 37	2 06	140 00 00	70 16 32	38 09 05
30	Crossing Arkansas river	Altair	8 29 17	2 06	120 41 40	60 21 25	38 07 52
31	do do	Jupiter	—22 12 05	2 06	59 21 30	29 40 24	38 07 30
Aug. 1	Apishpa river, noon halt	Sun	17 55 40	2 06	139 10 40	69 51 57	38 03 43
2	do	Jupiter	—22 12 04	2 06	59 43 20	29 51 24	37 56 42
3	do noon halt	Sun	17 24 37	2 11	138 39 45	69 26 34	37 48 03
3	do	Jupiter	—22 12 05	2 11	60 03 10	30 01 20	37 46 35
4	do noon halt	Sun	17 08 39	1 37.5	138 16 20	69 24 34	37 44 06
4	In cañon	Jupiter	—22 12 07	1 37.5	60 04 25	30 01 44	37 46 09
6	Cuchara river	Sun	16 35 54	1 37.5	137 22 00	68 57 25	37 38 30
6	do	Altair	8 29 08	1 37.5	121 40 00	60 50 24	37 38 44
7	do	Sun	16 19 08	1 37.5	136 47 45	68 40 17	37 38 51
8	Huerfano butte	do	16 02 05	1 37.5	137 04 30	68 17 01	37 45 04
8	Near Huerfano river	Altair	8 29 09	1 37.5	121 27 45	60 44 16	37 44 52
9	do noon halt	Sun	15 44 47	1 37.5	135 30 25	68 01 37	37 43 10
9	do camp	Altair	8 29 09	1 37.5	121 29 10	60 45 00	37 44 09
10	Valley, noon halt	Sun	15 27 14	1 37.5	134 56 50	67 44 49	37 42 25
14	In Sangre de Cristo Pass	do	14 14 28	30	132 46 30	66 38 35	37 36 52
17	do noon halt	do	13 17 41	2 00	130 52 00	65 42 36	37 35 05
18	Pass, on creek	do	12 58 14	2 00	130 20 55	65 27 03	37 31 10
21	Utah creek	do	11 58 58	2 00	128 26 35	64 29 54	37 29 04
22	Fort Massachusetts	do	11 38 53	2 00	128 43 55	64 06 54	37 31 59
23	White Mountain spring	Altair	8 29 11	2 05	121 56 10	60 58 45	37 30 26
26		Sun	10 16 19	2 05	124 26 40	62 29 57	37 47 22
27		do	9 55 16	2 05	123 21 30	61 57 22	37 57 24
28	Leroux creek	do	9 34 04	2 05	123 33 50	61 31 49	38 02 15
29	Homans' creek	do	9 12 43	2 05	121 22 50	60 58 01	38 14 42
29	Branch Puncha creek	Altair	8 29 11	2 05	120 07 00	60 04 07	38 25 04
30	Homans' creek	do	8 29 11	2 05	120 20 00	60 10 38	38 18 33
Sept. 1	Sahwatch creek, noon halt	Sun	8 07 46	2 00	119 26 50	59 59 59	38 07 46
2	Coochetopa Pass	Altair	8 29 11	2 00	120 30 00	60 16 37	38 12 35
3	do	do	8 29 11	2 00	120 13 00	60 07 06	38 22 06
4		Sun	7 01 31	2 00	116 46 15	58 39 40	38 21 50
5	Noon halt	do	6 39 15	2 00	115 49 20	58 11 21	38 27 53
5	Coochetopa creek	Altair	8 29 11	2 00	119 55 50	59 58 30	38 30 41
6	Noon halt	Sun	6 16 51	2 00	114 56 20	57 44 43	38 32 08
6	Grand river	Altair	8 29 11	2 00	119 56 00	59 58 34	38 30 38
7	do	do	8 29 11	2 00	119 59 10	60 00 10	38 29 02
10		Sun	4 46 18	2 00	112 06 25	56 19 45	38 26 33
11		do	4 23 27	2 00	111 23 35	55 58 20	38 25 07
12	Cebolla creek	Altair	8 29 12	2 00	120 10 10	60 05 47	38 23 26
13		Sun	3 37 32	2 00	109 56 30	55 14 47	38 22 44
14	Noon halt	do	3 14 22	2 00	109 05 50	54 49 26	38 24 56
14	Cedar creek	Altair	8 29 12	2 00	119 58 40	59 59 55	38 29 17
16	Noon halt	Sun	2 28 05	1 38	107 11 20	53 51 58	38 36 07
16	Uncompahgra river	Altair	8 29 12	1 38	119 32 25	59 46 34	38 42 38
17		Sun	2 04 52	1 38	106 10 05	53 21 20	38 43 21
18		do	1 41 36	1 38	104 59 00	52 45 46	38 55 50
18		Altair	8 29 12	1 38	119 06 00	59 33 20	38 55 52
19	Noon halt	Sun	1 18 18	1 38	104 01 50	52 16 43	39 01 35
20	do	do	54 58	1 38	103 04 10	51 48 22	39 06 36
20	Nah-un-kah-rea river	Altair	8 29 12	1 38	118 42 55	59 21 48	39 07 24
21	Noon halt	Sun	31 36	1 38	102 11 00	51 21 48	39 09 49
21	Little Salt creek	Altair	8 29 12	1 38	118 31 20	59 16 01	39 13 12
22	Noon halt	Sun	8 13	1 38	101 15 40	50 54 09	39 14 15
23	Bitter creek	do	— 15 11	1 38	100 45 10	50 38 52	39 05 57
24		do	— 38 35	1 55	99 58 25	50 11 38	39 09 47
28	Noon halt	do	— 2 12 14	1 55	97 07 05	48 49 56	38 57 50
28		Altair	8 29 13	1 55	119 12 05	59 36 32	38 52 40
29	Noon halt	Sun	— 2 35 37	1 55	96 34 25	48 33 35	38 50 48
29		Altair	8 29 13	1 55	119 15 45	59 38 22	38 50 50
30	Noon halt, Spanish trail	Sun	— 2 58 59	2 05	95 37 35	48 05 16	38 55 45
30	Green river	Altair	8 29 13	2 05	119 02 45	59 31 46	38 57 26
Oct. 2	Noon halt	Sun	— 3 45 36	2 05	93 57 40	47 15 19	38 59 05

II.—*Geographical Positions*—Continued.

Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
1853.			° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″
Oct. 3	Noon halt	Sun	— 4 08 51	2 05	92 55 45	46 44 22	39 06 47
3		Altair	8 29 13	2 05	118 30 00	59 15 35	39 13 38
4	Noon halt	Sun	— 4 32 03	2 05	91 48 05	46 10 31	39 17 26
4	White river	Enif	9 12 27	2 05	119 45 50	59 53 30	39 18 57
5	Clever creek	do	9 12 27	2 05	119 35 20	59 48 15	39 24 12
6	Noon halt	Sun	— 5 18 17	2 05	89 56 30	45 14 42	39 27 00
6	White river	Altair	8 29 13	2 05	118 03 40	59 02 25	39 26 48
7	Noon halt	Sun	— 5 41 19	2 05	89 17 35	44 55 15	39 23 26
8	do	do	— 6 04 17	2 05	88 51 00	44 41 57	39 13 46
8	Branch San Rafael river	Altair	8 29 13	2 05	118 34 15	59 17 43	39 11 30
10	Garambulla creek, noon halt	Sun	— 6 49 58	1 57.5	89 34 35	44 03 41	39 06 21
10	do do	Altair	8 29 13	1 57.5	118 48 00	59 24 31	39 04 42
11	Noon halt	Sun	— 7 12 39	1 57.5	87 05 30	43 49 08	38 58 13
12	do	do	— 7 35 13	1 57.5	86 35 10	43 33 58	38 50 49
13	Summit of Wahsatch Pass	do	— 7 57 42	1 57.5	86 00 30	43 16 42	38 45 37
13	Camp	Enif	9 12 27	1 57.5	120 45 10	60 23 08	38 49 19
14	Noon halt	Sun	— 8 20 03	1 57.5	85 06 50	42 49 50	38 50 07
15	do	do	— 8 42 23	1 57.5	84 25 15	42 38 57	38 48 40
16	Wahsatch Pass	do	— 9 04 25	1 57.5	83 37 33	42 05 09	38 50 27
17	Noon halt	do	— 9 26 26	1 32.5	82 48 35	41 40 26	38 53 08
17	Sevier river	Enif	9 12 27	1 32.5	120 24 40	60 12 39	38 59 48
18	San Pete creek	do	9 12 27	1 32.5	120 04 20	60 02 29	39 09 58
19	do	Sun	—10 10 02	1 32.5	80 45 50	40 39 02	39 10 56
20	Sevier river	do	—10 31 36	1 32.5	79 40 10	40 06 01	39 22 23
21	Noon halt, California road	do	—10 52 00	1 32.5	79 05 15	39 48 42	39 19 18
22	Cedar springs	Markab	14 25 14	1 32.5	130 37 20	65 19 05	39 06 09
23	do	Sun	—11 35 19	1 32.5	78 04 40	39 18 22	39 06 18
24	Sevier river	do	—11 56 13	1 32.5	76 53 35	38 42 50	39 20 57
29	California road	do	—13 37 51	1 25.5	74 06 15	37 19 07	39 03 02
30	do	do	—13 57 34	1 25.5	73 27 05	36 59 33	39 02 53
Nov. 2	Nephi	do	—14 55 23	1 25.5	70 13 30	35 22 41	39 41 56
Dec. 6	Salt Lake City	do	—22 34 32	1 37	52 49 00	26 39 51	40 45 37

III.—*Table of Distances travelled, including those from point to point at which barometrical observations were made, on the route from Westport, Missouri, to Great Salt Lake City.*

Date.	Number of camp.	Intermediate distances.	Day's travel.	Distance from Westport.	Localities.
1853.		*Miles.*	*Miles.*	*Miles.*	
June 22	1			4.92	
23	2		8.70	13.62	Indian creek.
24	3		8.42	22.04	Cedar creek.
25	4		9.40	31.44	Bull creek.
26	5		20.25	51.69	Willow springs.
27	6		23.84	75.53	110 mile creek.
28	7		20.56	96.09	Prairie Hen creek.
29	8		21.02	117.11	Rock creek.
30	9		8.19	125.30	Elm creek.
July 1	10		16.55	141.85	Diamond spring.
2	11		15.70	157.55	Lost spring.
3	12		17.82	175.37	Cotton-wood creek.
5	13		22.59	197.96	Turkey creek.
6	14		23.18	221.14	Little Arkansas.
7	15		20.44	241.58	Big Cow creek.
8	16		20.10	261.68	Big Bend of the Arkansas.
9	17		7.23	268.91	Walnut creek.
13	18		28.59	297.50	Pawnee fork.
14	19		20.71	318.21	Coon creek—first fork.
15	20		18.50	336.71	Do. second fork.
16	21		28.62	365.33	Arkansas river, near Fort Atkinson.
19	22		25.32	390.65	Do. near Cimmeron ford.

III.—*Table of Distances travelled, &c.*—Continued.

Date.	Number of camp.	Intermediate distances.	Day's travel.	Distance from Westport.	Localities.
1853.		*Miles.*	*Miles.*	*Miles.*	
July 20	23		19.90	410.55	Arkansas river.
21	24		22.05	432.60	Do.
22	25		21.73	454.33	Do.
23	26		24.38	478.71	Do.
25	27		21.87	500.58	Do.
26	28		20.28	520.86	Do.
27	29		23.26	544.12	Do.
28	30		15.08	559.20	Arkansas river, below Bent's Fort.
29	31		24.00	583.20	Arkansas river.
30	32		10.00	593.20	Arkansas river, opposite mouth of Apishpa.
August 2	33		14.64	607.84	Apishpa river.
3	34		12.98	620.82	Do.
4	35		15.26	636.08	Between Apishpa and Cuchara.
5	36		17.07	653.15	Near Cuchara river.
6	37		10.39	663.54	Cuchara river.
8	38		10.09	673.63	Huerfano river, near Butte.
9	39		14.54	688.17	Huerfano river, above the gorge.
10	40		7.59	695.76	Base of mountain.
11	41		5.12	700.88	Near summit of pass.
13		.70		701.58	First summit
13		.32	1.02	701.90	Descent from summit.
13	42	3.48	3.48	705.38	Sangre de Cristo creek.
17	43		5.34	710.72	Sangre de Cristo valley.
19	44		10.57	721.29	Utah creek.
23	45		10.75	732.04	White Mountain spring.
24	46		13.46	745.50	Near Roubideau's Pass.
25	47		9.78	755.28	Near Williams' Pass.
26	48		9.06	764.34	Chatillon creek.
27	49		11.72	776.06	Leroux creek.
29	50		5.96	782.02	Homans' creek.
30		10.54			Sahwatch spring.
30	51	4.66	15.20	797.22	Sahwatch creek.
31	52		12.27	809.49	Do.
Sept. 1	53		15	824.49	Foot of Coochetopa Pass.
2					Station No. 1.
2		1.62			Station No. 2.
2		1.39			Station No. 3.
2		.58			Station No. 4.
2		.24			Summit of Coochetopa Pass, No. 5.
2	54	1.33	5.16	829.65	West of pass.
3		2.24			Station No. 1.
3		2.15			Station No. 2.
3		2.05			Station No. 3.
3		3.47			Station No. 4.
3		1.28			Station No. 5.
3		1.74			Station No. 6.
3		2.14			Station No. 7.
3		2.20			Station No. 8.
3	55	2.73	20	849.65	Near Camp Rock.
5		1.30			Station No. 1.
5		3.16			Station No. 2.
5		2.88			Station No. 3.
5		1.79			Station No. 4.
5		1.51			Station No. 5.
5		1.72			Station No. 6.
5		2.28			Station No. 7.
5	56	1.24	15.88	865.53	Coochetopa creek.
6		1.50			Station No. 1.
6		.89			Station No. 2.
6		1.08			Station No. 3.
6		2.16			Station No. 4.
6		1.46			Gate Rock.
6		1.39			Station No. 5.
6		2.88			Station No. 6.
6		.57			Crossing Grand river.
6		.83			Station No. 7.
6	57	1.99	14.75	880.28	Grand river.

III.—*Table of Distances travelled, &c.*—Continued.

Date.	Number of camp.	Intermediate distances.	Day's travel.	Distance from Westport.	Localities.
1853.		*Miles.*	*Miles.*	*Miles.*	
Sept. 7	58		14	894.28	Grand river.
8	59		4	898.28	Mountain ravine.
9		2.92			East summit of Lake Fork bank.
9	60	1.08	4	902.28	Lake fork.
10		.54			Summit of bank west of Lake fork.
10	61	4.16	4.70	906.98	Mountain valley.
12	62		13.18	920.16	Cebolla creek—first branch.
13	63		3.75	923.91	Do. second branch.
14		3.78			Summit of mountain.
14	64	9.22	13.00	936.91	Cedar creek.
15		2.03			Crossing of Cedar creek.
15	65	10.26	12.29	949.20	Uncompahgra river.
16	66		18.23	967.43	Do.
17	67		20.33	987.76	Hill.
18	68		8.45	996.21	
19	69		13.40	1009.61	Blue river.
20	70		9.10	1018.71	Do.
21	71		14.29	1033	Little Salt creek.
22	72		21.75	1054.75	Bitter creek.
26	73		16.28	1071.03	Rain-water creek.
27	74		5.67	1076.70	Hill.
28	75		16.72	1093.42	Creek in cañon.
29	76		14.10	1107.52	Junction of creeks.
30	77		14	1121.52	Green river.
Oct 1	78		1.08	1122.60	Do.
2	79		16.75	1139.35	Akanaquint spring.
3	80		15.78	1155.13	Dry creek.
4	81		9.82	1164.95	White river.
5	82		8.70	1173.65	Clever creek.
6		10.86			Station on White river.
6	83	.26	11.12	1184.77	Hill.
7		3.52			Station.
7	84	9.74	13.26	1198.03	Standing Water creek.
8		7.61			Near San Rafael river.
8	85	5.59	13.20	1211.23	San Rafael river.
9		2.19			Spanish trail.
9	86	9.21	11.40	1222.63	Garambulla river.
11		7.85			Dividing ridge.
11	87	5.61	13.46	1236.09	Big Rock creek.
12		5.82			Crossing stream.
12	88	9.83	15.65	1251.74	Oak spring.
13		.61			Station No. 1.
13		1.08			Station No. 2.
13		1.66			Station No. 3.
13		1.34			Station No. 4.
13		1.74			Station No. 5.
13		.22			Summit of Wahsatch Pass.
13		1.90			Station No. 6.
13		1.70			Station No. 7.
13	89	.97	11.22	1262.96	Salt creek.
14		.84			Station No. 1.
14		1.25			Station No. 2.
14		.90			Station No. 3.
14		.60			Station No. 4.
14		.31			Station No. 5.
14		.11			Station No. 6.
14		.20			Station No. 7.
14		.12			Station No. 8.
14	90	.58	5	1267.96	Swambah creek
15		.33			Station No. 1.
15		.54			Station No. 2.
15		.16			Station No. 3.
15		.60			Station No. 4—summit.
15		2.24			Station No. 5.
15		.78			Station No. 6.
15		1.60			Station No. 7.
15		.50			Station No. 8.
15	91	1.75	8.5	1276.46	Ungottahbikin creek.

III.—*Table of Distances travelled, &c.*—Continued.

Date.	Number of camp.	Intermediate distances.	Day's travel.	Distance from Westport.	Localities.
1853.		*Miles.*	*Miles.*	*Miles.*	
Oct. 17		1.20			Station No. 1.
17		.65			Station No. 2.
17		2.25			Station No. 3.
17		1.56			Station No. 4.
17		.84			Station No. 5.
17		.84			Station No. 6.
17		1.15			Station No. 7—Salt creek.
17		2.63			Station No. 8.
17	92	3.13	14.25	1290.71	Sevier river.
18	93		11.82	1302.53	San Pete creek.
19	94		19.10	1321.63	Sevier river.
20	95		2.45	1324.08	Do.
21		4.51			Summit of ridge north of Lake valley.
21		7.39			In Lake valley.
21		3.52			Ridge south of Lake valley.
21	96	8.78	24.20	1348,28	Cedar springs.
23	97		18.13	1366.41	Sevier River valley.
24	98		7.30	1373.71	Sevier river.
25	99		14.25	1387.96	Do.
26	100		7.45	1395.41	Foot of mountain.
27	101		20.93	1416.34	Cedar springs.
28	102		3.46	1419.80	Pioneer creek.
31	103		28.24	1448.04	Sevier river.
Nov. 1	104		24.85	1472.89	City of Nephi.
3	105		25.18	1498.07	City of Payson.
4	106		19.23	1517.30	City of Provo.
5	107		14	1531.30	American fork.
6	108		15.40	1546.70	Willow creek.
7	109		11.45	1558.15	Cotton-wood creek.
8	110		7.80	1565.95	Great Salt Lake City.

IV.—*Table of Distances travelled on the line followed from Westport, Missouri, via Fort Riley, Kansas Territory, to Walnut Creek.*

Date.	No. of camp.	Day's travel.	Distance from Westport.	Localities.
1853.		*Miles.*	*Miles.*	
June 22	1	4.92	4.92	
23	2	8.70	13.62	Indian creek.
24	3	8.42	22.04	Cedar creek.
25	4	9.40	31.44	Bull creek.
26	5	15.32	46.76	Wahkarrussi river.
27	6	20.92	67.68	Big spring.
28	7	23.40	91.08	Branch of Mission creek.
29	8	18.75	109.83	Branch of Il-a-heek-cou-a-sa creek.
30	9	18.46	128.29	Small creek, three miles from K. river.
July 1	10	15.75	144.04	Rivulet, nine miles from K. river.
2	11	12.09	156.13	Mahungasa creek,
3	12	2.50	158.63	Bluffs opposite Fort Riley.
4	13	13.13	171.76	Spring between the Smoky Hill and Republican forks.
5	14	24.46	196.22	Creek in Smoky Hill Fork valley.
6	15	10.58	206.80	Nepeholla river.
7	16	8.92	215.72	Saline fork.
8	17	23.09	238.81	Branch of Saline.
9	18	22.76	261.57	Oak Spring creek.
11	19	29.00	290.57	Arroyo creek.
12	20	15.62	306.19	Walnut creek, at Santa Fé crossing.

APPENDIX A.

Letters relating to the Progress of the Survey of the Route near the 38th and 39th parallels, in charge of Captain Gunnison.

I.—Letter dated June 20, 1853, Camp, Shawnee reservation, from Captain Gunnison to the Secretary of War, indicating the line which will be followed in crossing the Plains.

II.—Letter dated August 22, 1853, Camp, Utah creek, near Fort Massachusetts, from Captain Gunnison to the Secretary of War, reporting the progress of the survey.

III.—Letter dated August 22, 1853, Camp, Utah creek, near Fort Massachusetts, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey.

IV.—Letter dated September 20, 1853, Camp No. 70, Grand river, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey.

V.—Letter dated September 23, 1853, Camp 72, Bitter creek, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, forwarding a rude copy of the field-work of the survey.

VI.—Letter dated October 29, 1853, Camp, near Fillmore, Utah Territory, from Lieutenant Beckwith to Colonel J. J. Abert, reporting the progress of the survey, requesting instructions, and indicating future operations.

I.—*Letter dated June 20, 1853, Camp, Shawnee Reservation, from Captain Gunnison to the Secretary of War, indicating the line which will be followed in crossing the Plains.*

CAMP, SHAWNEE RESERVATION,
June 20, 1853.

SIR: I have the honor to say that I have organized my party for the survey assigned to my command, and, with the escort under Brevet Captain Morris, propose to proceed along the Smoky Hill, until necessary to deflect from it, nearly as possible in a direct line, to the mouth of the Huerfano. This will give a new exploration a part of the way, and very desirable to meet the views of those advocating the route, and, I hope, it will not much delay me. It will also be useful for the new fort on the Republican, in order to know whether a short route to Santa Fé may be taken across to the Arkansas. I submit the following names as assistants on the survey:

Dr. James Schiel, surgeon and naturalist.
Sheppard Homans, astronomer.

The gentleman engaged as civil engineer was taken ill at Elmira, New York, and has not yet joined; but I hope he will yet be able to reach us, as our marches, for a few days, will be short.

I have the honor to be, sir, your most obedient servant,

J. W. GUNNISON,
Captain Topographical Engineers.

Hon. JEFFERSON DAVIS, *Secretary of War.*

II.—*Letter dated August 22, 1853, Camp, Utah Creek, near Fort Massachusetts, from Captain Gunnison to the Secretary of War, reporting the progress of the survey.*

CAMP, UTAH CREEK, NEAR FORT MASSACHUSETTS,
August 22, 1853.

SIR: Availing myself of your permission to keep you acquainted with my progress on the survey, I have the honor to say that my party has crossed the first great range of the Rocky mountains safely and easily to the valley of San Luis.

My exploration on the west side of the Kansas was eminently successful, in developing the existence of a plain, slightly inclined, which cuts off the eastern bend of that river at the Smoky Hill. Thence I came, in the same course, to Walnut creek, and descended to its lower part, and afterwards reconnoitred above. The result would be that a *road* should take this more direct line from Fort Riley to Walnut creek, and cross to Pawnee fork, following it and branches to within five or six miles of the Arkansas; thus cutting off the "Big Bend," and strike the latter river near "Aubrey's crossing." I beg leave to refer to Captain (Lieutenant) Woodruff's map of the Pawnee fork in explanation—a manuscript copy of which I saw at Fort Atkinson.

Those in my command who had been in this country in winter, could not recognise places and streams in a different season. Misled by the maps of the Upper Arkansas, I took the Apishpa for the Huerfano, and thoroughly explored the country below, and have added to the geography of that region at the expense of much personal labor.

An intelligent man, of thirty years' mountain experience, was procured at the Greenhorn ranch, for a guide to the "Sangre de Cristo" Pass. By a circuitous route we were led to the mule-path crossing over a high mountain or ridge, which the guide declared the only way. But I reconnoitred the dividing ridge from near the Sierra Blanca to the Spanish peaks, while the train was cutting through bushes and working a road, under my able assistant officer, down the Sangre de Cristo creek to this valley.

My efforts were rewarded by finding a summit level, very low, and over which a road can easily be made, with almost a single grade of a few feet to the mile, to the Arkansas plains. As an obstacle to a railroad, it deserves not the name; and the pass can be made without going up what could be called a hill—a mere slope. The work bestowed on the Muleteer mountain track would have opened a feasible road for supplies to this post from the States, and, perhaps, ultimately the route to Santa Fé.

There is a good wagon-track now made, where we have come with heavily loaded teams. A large flock and herd are closely following us. The owner has been to one of my camps, and returned to the Arkansas to bring on his stock, as the grass is extremely good, and this route will not require wintering in the Basin.

My observations on the east side lead me to think there is a pass to the north, more direct and as feasible, which I shall soon examine.

We are to start early to-morrow morning for the north and Coochetopa. I have secured the services of A. Leroux to the Spanish trail, whence he will return to guide Lieutenant Whipple. All accounts agree in presenting greater difficulties ahead; but I hope to report in a few weeks from the Great Basin.

Great press of business, and a severe headache, must plead my apology for the style of this letter.

I have the honor to be, your most obedient servant,

J. W. GUNNISON,

Captain Top. Engs., Commanding Central Pacific Railroad Survey.

Hon. JEFFERSON DAVIS, *Secretary of War.*

III.—*Letter dated August* 22, 1853, *Camp, Utah Creek, near Fort Massachusetts, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey.*

CAMP, UTAH CREEK, NEAR FORT MASSACHUSETTS,

August 22, 1853.

SIR: I have honor to report my arrival in the San Luis valley, having crossed the Rocky mountain eastern range without accident. We have had much labor in removing trees and bushes, and cutting down banks, to work up the east side of a high ridge, over which my guide

carried me, assuring me that it was the only practicable wagon route to the Sangre de Cristo. But I have discovered, in searching along the summit level, a very low depression, by which we can pass through, instead of over, the hills, where the muleteer paths usually go. This new pass, to a branch of the Huerfano, presents no real obstruction to any kind of a road.

The route is well grassed, and our animals are in fine condition, having recruited, while our labors in road-making and exploring the mountains have been more onerous than in the plains.

The character and place of my duties have prevented the usual reports on the 1st of the month. Should our exertions be favored, as thus far, I hope to make the September report, and forward by the California mail, from some place in Utah. But all representations concur in presenting a difficult region to traverse to the Great Basin.

I beg leave to enclose a communication to the honorable Secretary of War, with the request that it be presented to him.

It was my desire to make a more detailed account, but illness prevents my writing more to-night, and the train has received orders, and is prepared for an early departure towards the north to-morrow morning. I will only add that I followed the Kansas River valley to the new fort (Riley) on Pawnee river, and crossing, took a very level and direct route on the northerly side; crossed the Nepeholla (Solomon's fork) and Saline rivers by ferrying on rafts of logs, as they were swollen by recent rains; and then, cutting off the southern bend of the Kansas at the Smoky Hill, passed in the same direction to the Walnut creek and Pawnee forks of the Arkansas. Availing myself of Captain Woodruff's sketches, and the reconnoissance I made, the true route for a military road would be by way of those creeks, to a point on the Arkansas, above Fort Atkinson, which would subserve both the Santa Fé and Fort Massachusetts or Taos directions.

I now proceed to the north, to the Coochetopa Pass, intending to survey the Robideau Pass on the way, which, I think, must present a more direct route to California than the one I have discovered, the latter being on the Taos course, and too far south, if any place of crossing the mountains feasible for a road can be had further north.

Then, under guidance of Watkin Leroux, we are to go to the Spanish trail, from which place he is to return, in order to join Lieutenant Whipple.

I have the honor to be, Colonel, your obedient servant,

J. W. GUNNISON,

Captain Top. Engs., Commanding Central Pacific Railroad Survey.

Colonel J. J. ABERT,

Chief Topographical Engineers.

IV.—*Letter, dated September* 20, 1853, *Camp No.* 70, *Grand river, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, reporting the progress of the survey.*

CAMP NO. 70, GRAND RIVER, UTAH TERRITORY,
September 20, 1853.

SIR: I have the honor to report the operations upon the Central Pacific Railroad Survey since it was placed under my direction, in May.

The party for the survey was organized and directed to St. Louis, where the requisite purchases were made. By the aid of Colonel R. Campbell, the business of fitting out was much expedited. The teams were bought and rendezvoused near Westport, and I proceeded to Fort Leavenworth for the escort, which has proved very efficient in many respects of guard and for labor, under the command of Brevet Captain Morris, and Lieutenant Baker, of the Mounted Rifles. In the march, and other duties, I have been greatly assisted by an experienced officer, Lieutenant E. G. Beckwith, of the Artillery.

I considered it necessary to demonstrate practically the character of the route, by taking a wagon train for the supplies. The main part was sent, under charge of Lieutenant Beckwith, on the Arkansas road, and, with one team, I proceeded by the Kansas to the Smoky Hill valley, and nearly direct in a westerly course to Walnut creek, on new ground much of the way, where I found a very eligible site for any description of road. Thence my route was along and in the vicinity of the Arkansas to the Apishpa creek, where I crossed the river, and explored the Huerfano country up to the pass of El Sangre de Cristo. The train passed over the usual mountain track, but, after a careful reconnoissance, I found a very low depression in the mountain ridge, by way of a small creek of the Huerfano valley, which makes the crossing very easy into the valley of San Luis, provided a little labor is bestowed to cut the small bushes and level the banks on the creek. It requires much labor on the higher pass, and also to cut the road out on the Sangre de Cristo creek. And on the unbroken track generally, the work has been severe in the mountain region, particularly for sixty miles along Grand river, where we were forced over a connecting mountain between the Elk and San Juan mountains.

The Musca (Robideau) and Williams' passes were reconnoitred, and found very inadmissible for roads.

I heard of and explored one, however, at the head of San Luis valley of the Del Norte, which led down the Puncha creek to the Arkansas plains, above its first cañon, or defile. The approach to it would be either by way of the Wet Mountain valley and Hardscrabble creek, or, if found practicable, through the defile along the Arkansas. It is far superior to either the Musca or Williams' passes for crossing the dividing ridge.

The Coochetopa Pass was not very difficult for our teams, and thence to Grand river the descent was easy. That river runs in deep gorges, with only now and then a small valley, which forced us upon the rocky hills, cut through transversely by creeks, whose gullies were difficult to cross without much labor. This delayed us considerably on sixty miles to the Uncompahgra, since arriving at which our route has been easier, but we have lost the fine grass that kept our animals in good condition up to that point. The Grand and Nah-un-karea rivers are large, rapid streams, and only at low stages can they be easily forded.

A summary result may be thus stated of the operations: One thousand and fifty (1,050) miles en route travelled with 18 wagons; 520 miles of new road made on unbroken ground; 4 rivers (besides smaller streams as difficult) ferried or forded; 79 new or rare varieties in the botanical department in the plains, and 48 in the mountains; 27 varieties of mammals and birds; 26 of reptiles and fishes; 50 or 60 of insects; 213 observations for astronomical stations.

The topography of the line, and all the prominent hills in sight, are taken and daily plotted with approximate accuracy.

The geology of the route has also been carefully noted, and specimens collected.

The Utah Indians have appeared friendly, and the health of the party has been pretty good. I secured the services of A. Leroux and ——— Michael, two of the most competent men in the mountains, who are to take us to the Spanish trail; from thence I shall be without a guide. They are to return in a few days to Taos, and by them I expect to forward my dispatches.

Most respectfully submitted:

J. W. GUNNISON,
Captain Top. Engineers, in charge of C. P. R. R. Survey.

Colonel J. J. ABERT,
Chief Topographical Engineers.

V.—*Letter, dated September* 23, 1853, *Camp* 72, *Bitter Creek, Utah Territory, from Captain Gunnison to Colonel J. J. Abert, forwarding a rude copy of the field-work of the survey.*

CAMP 72, BITTER CREEK, UTAH TERRITORY,
September 23, 1853.

SIR: I have the honor to submit a succinct report of our operations to the 20th instant. Amid the bustle of camp duties it is necessarily a mere abstract, for a strong necessity urges us forward. We have had miserable grass and water for much of the last one hundred miles, neither very accessible, and it is growing late for crossing the Wahsatch range, and any great delay might be injurious. I have caused a copy of the field-work map to be made, which I am sorry to send in such a rough dress, but the guide is about to leave for Taos.

In three weeks I hope to reach the Mormon settlements. From thence it will be requisite to our subsistence that funds be estimated for, to be placed in the hands of Colonel R. Campbell, at St. Louis, which will be available in the mountains.

I have the honor to be, most respectfully, your obedient servant,

J. W. GUNNISON,
Captain Topographical Engineers.

Col. J. J. ABERT, *Chief Top. Engineers.*

VI.—*Letter, dated October* 29, 1853, *Camp near Fillmore, Utah Territory, from Lieut. Beckwith to Col. J. J. Abert, reporting the progress of the survey, requesting instructions, and indicating future operations.*

CAMP NEAR FILLMORE, UTAH TERRITORY,
October 29, 1853.

COLONEL: The death of the late Captain J. W. Gunnison, Topographical Engineers, in charge of the Central Pacific Railroad Survey, whose death, with the particulars, is being communicated by Captain R. M. Morris, Mounted Rifles, officially to the Adjutant General, devolves upon me the duty of requesting instructions from the Hon. Secretary of War for my future guidance. The short time allowed me before the departure of the express, which goes hence in time to reach Great Salt Lake City before the departure of the mail from that place, on the first proximo, for the States, does not admit of my making any detailed statement, even of the operations of the surveying party during the season, which is closing so disastrously and painfully to us. Besides, the report which the late Captain made on, I think, the 20th of September last, of his operations up to that date, (an annual statement of operations as an officer of Topographical Engineers, in charge of public duties,) and forwarded through New Mexico, and which, it is presumed, came safely to hand, makes any statement as to the preceding part of his survey unnecessary. On that date we were on or near Grand river, travelling towards the Spanish trail, which we struck between that river and the Green; following it but a few miles beyond the latter stream, we left it, passing north and west to White river, (a small branch of Green river,) which we followed up a few days, and then skirted along the base of the Wahsatch mountains, crossing the St. Rafael, also a small stream, with its numerous branches, to the pass in those mountains known as the Wahsatch Gap. After leaving it to examine White river, travelling by a very circuitous route for seventy or seventy-five miles, we again returned to the Spanish trail, soon after passing the St. Rafael. This trail, as is well known to you, passes through the Wahsatch Pass, a few miles beyond which we left it and struck off directly for the Sevier river, distant from the pass about thirty miles, and then followed down that stream to where it is crossed by the road leading from Great Salt Lake City to California, via Vegas de Santa Clara. We here crossed the Sevier and the range of mountains lying to the south and west of that stream, probably at the point at which Frémont crossed them in 1844, into the valley of the Sevier lake. Leaving this range of mountains, we passed northwest to the Sevier river again, a few miles above

where it enters the lake, which Captain Gunnison was about to explore, with the country to the west of it, when he was killed. This survey, it was supposed, would not detain him beyond two or three days. Thence he proposed to go north, if possible turning the range of mountains through which the Sevier passes; but if not practicable, then to go through the pass of that river north to Utah lake and Salt Lake City, examining, if possible, the Timpanogos Pass, when opposite it. You will see, therefore, that but a trifle of labor remained to be accomplished in the field, when operations were so suddenly terminated, for it is no longer deemed safe to explore these districts until better informed of the numbers and present hostile condition of nearly all of the Indians of the Territory, did not the condition of our supplies and the advanced state of the season forbid it.

A few of Captain Gunnison's notes, those since October 8th, when we were on the St. Rafael, he had with him, and they were carried off by the Indians; also, some of the topographical notes and sketches of his assistant, Mr. Kern; but I have not yet been able to ascertain to what precise point, but hope the loss will not be great. I have, through Mr. Call, the president of the settlement, now here, who extends to us all the assistance in his power, sent an express to the chief of the band which was engaged in the massacre, and entertain a faint hope that I may recover these papers and books,* and also the instruments, with which we can ill dispense. I shall keep the assistants left of the party busily employed during the winter in bringing up their observations and notes, and, if possible, employ a draughtsman to supply the vacancy occasioned by Mr. Kern's death. Should no other instructions be received, intended for Captain Gunnison, than those furnished him before commencing the survey, and should I receive none myself before the proper season arrives for commencing spring operations, I shall, if I am able to get the means, continue the survey, in conformity with those instructions. Captain Gunnison's party was employed for the trip, and cannot, therefore, be discharged until we again arrive in the States. As all the funds for this survey were in Captain Gunnison's name, I am left without the means of paying assistants and employés, as I am without those for subsisting them during the winter, &c., &c. I have, therefore, the honor to request that I may be furnished with authority to draw upon the proper department for the amount necessary to meet the demands against the survey, present and prospective. Could this arrangement be effected, it would relieve me from the risk and responsibility of transporting money with me over vast districts of uncivilized territory, loss by mails in coming to me, &c. If this may not be done, however, I have then the honor to request that drafts for small amounts may be sent to me without delay, to be used from time to time, as the mails cannot be depended upon to arrive with any regularity. I am not able to estimate accurately the amount of money expended by Captain Gunnison in this survey up to the time of his death, but believe it will not vary materially from eighteen thousand dollars, and I estimate the expense of the party, including wages and subsistence of men, and wear and tear of transportation, at ten or twelve hundred dollars per month. It may be necessary that I should be furnished with an order, directing me to pay the dues against the survey previous to the death of Captain Gunnison. If so, I have to request that it may be furnished to meet the unpaid amounts due the men of the party, and one thousand dollars, in addition to the monthly estimate above, furnished me to meet these amounts.

The public accounts of Captain Gunnison will be forwarded to the bureau of Topographical Engineers, as soon after arriving in Salt Lake City as it is possible to select them from his other papers.

I am, sir, most respectfully, your obedient servant,

E. G. BECKWITH,

First Lieutenant 3d Artillery.

Colonel J. J. ABERT,

Chief of the Corps of Top. Engs., Washington City, D. C.

* The notes and sketches were all thus recovered.

APPENDIX B.

Explanations of Map and Illustrations.

The astronomical instruments taken by us into the field proved so imperfect that the longitudes deduced from observations made with them were very unreliable, and the longitudes for the map which accompanies this report, reckoned from the meridian of Greenwich, were, therefore, mainly derived from the published maps and reports of previous government explorations and surveys, by Nicollet and Frémont, for Saint Louis; Chouteau's trading-house, on the Kansas river; Fort Leavenworth, on the Missouri river; and Antelope island, in the Great Salt Lake; and by Professor D. W. Gœbel and Messrs. J. C. Brown and A. M. Lea for various points in the State of Missouri, as given by the land office surveys of that State, which were kindly furnished for that purpose by the Commissioner of the General Land Office; and for the Pacific coast, from the Coast Survey and Frémont's reports. The latitudes were deduced from observations made by Mr. Homans. The scale of the map is twelve miles to one inch, or 1 to 760,320 of nature.

The various systems of shading generally applied in drawing topographical maps are unfortunately, to a great extent, arbitrary, and will be frequently influenced, therefore, in maps of reconnaissances and rapid explorations of extensive territories, by the varied impressions which the same landscape produces, depending upon whether it is seen during the morning or evening light of the day, under a clear or clouded sky, in a dry or wet atmosphere, &c.—impressions which can only be reconciled to a certain degree by repeated examinations and careful measurements, still leaving unreconciled the different sentiments of the scientific as to the character of shading best adapted to express the features of the country surveyed. The value of maps depends, however, wholly upon the accuracy, extent, and sufficiency of their details, which cannot be left to the imagination without entirely misleading the reader, and conveying to him an erroneous view of the country delineated; and Mr. Egloffstein has, therefore, endeavored to give such a character to his topography as to present a distinct representation of the country as it appeared to him when taking his notes in the field. The altitude above the sea of the great interior plateau upon which these mountains are elevated, materially diminishes their apparent altitude from whatever direction they are approached; and as it is their actual appearance to the eye which is attempted to be represented, it equally influences the character of their delineation. The surfaces of these elevated plains, and of the valleys intermediate to the mountains, may, therefore, be regarded as planes of reference to which the mountain elevations are referred. In that part of the map embraced within the fully-shaded topography, the actual proportions of the territory occupied by plains and valleys, and by mountains, are given, necessarily defining the limits of each. The character of the slopes of the mountains and of their outlines in full, whether precipitous or gentle, and of the deep mountain chasms of the water-courses wherever they occur, and also the character of the summits of the mountains, whether rolling masses, sharp peaks, or serrated edges, is taken from nature, and if successful, will convey to the reader a correct idea of the country as seen by the observer.

The scale of shading used by Mr. Egloffstein for the full topography is one to eight, which is simply an expression for the proportions of the map which are occupied by shading lines, and was determined by taking the sum of the extreme angles of elevation and depression of the country to be represented, and dividing it into eight equal parts; then, so much of the country as ascends or descends at an angle not exceeding that of the first eighth of the whole angle, is represented by shading lines in proportion to its change of level, but covering not to exceed one-eighth of the whole surface. The second division is shaded, by the same rule, not to exceed two-eighths;

while the eighth division is entirely occupied by the shading lines, and is black. Much character is, however, given to topography by the length of the lines—long lines giving the appearance of long slopes, and broken and short lines short and broken slopes. In the skeleton topography, the scale of shading used on this map does not exceed one to three.

The extent of the fully shaded topography of the country traversed in 1854 is only limited by the field of observation, which frequently exceeds in extent one hundred miles of latitude, within which every object in sight during field operations was located with as much care as it was possible to attain, not only to enable us to present a clear and correct representation of the country, but to facilitate future explorations by an easy connexion with the present work, the correctness of which may be readily tested from the elevated stations to which our direct and side trails frequently lead. That portion of the map embracing the explorations of 1853 is also very extensive in its topographical delineations, and all the field notes taken have been exhausted in its construction. The topography adjacent to the trails is, in all cases, executed with accuracy of detail, and in its general features the same accuracy has been preserved within the field of observation. Where its character was known, but the information not derived from personal observation, the topography is given in skeleton, and is indicative of the general character of the country covered by it.

The materials for that portion of the map lying between the State of Missouri and Bridger's Pass of the Rocky mountains, and north of Forts Leavenworth and Riley, including the Plains, the Cheyenne and South Passes, and the Parks; and further west, the northern portion of the Great Salt Lake and of Bear river, were taken from Frémont's and Stansbury's reports and maps; and portions of the Humboldt river and valley were also taken from Colonel Frémont's explorations. The portion embracing the States of Missouri and Illinois was taken from lithographed and manuscript maps of the land office surveys of those States, forwarded for that purpose by Mr. John Loughborough, the surveyor general at St. Louis, and kindly furnished to us by Messrs. Wilson and Hendricks, successively Commissioners of the General Land Office. In unexplored portions of the country a few details have been derived from the descriptions of mountaineers, where a strong probability supported their statements.

The landscape views are presented with no purpose of representing the beauties of the scenery of the country, but to illustrate its general character, and to exhibit on a small scale the character of its mountains and cañones, and of its plains and valleys, in their respective positions and extents, as seen in nature, together with such passes as it was possible to represent without unduly increasing the number of views. Those of the country westward from the Great Salt Lake have, intimately connected as they are with the map of that portion of the country, a still greater value, as the same passes, mountains, and plains which are given on the one are presented in full on the other; and the positions on the map are also given from which the views were taken. The most valuable of them are very extensive, and an explanation of one will be sufficient for the understanding of the whole. They are taken, as will be seen at once, from elevated positions, and consequently partake somewhat of a panoramic character, and being of great extent, the ordinary inequalities of the surfaces of plains and slopes are not perceptible. But little attention has been paid to the beautiful execution of foregrounds, as it is only the general view of the country which it is desired to present. The smokes seen here and there indicate points at which we encamped. The bearings of the extremes of the views, and the names of their principal features, are given on the margin of each respective picture, the name of the object designated being directly under it, and the names nearest to the edge of the picture indicating the most distant objects; and as the same names are also given on the map, the two may be readily compared, and will serve to elucidate each other.

The first view west of the Great Salt Lake was taken from a peak near Antelope Butte, and presents on the extreme left the western slope of, and the passage (to the south of Pilot Peak) leading through, the first mountain range west of the desert which borders the lake on that side; immediately south of this passage, and extending considerably to the west, is an agglomeration

of mountain masses, the nearest of which is designated by its Indian name, Don-don, followed to the west by the Wa-cho-i, the northern end of which only is plainly seen; to the west of this range, but more distant, are considerable mountains, surmounted in May by a few snow-peaks, the most conspicuous of which bears the Indian name of Mo-ko-ga-ri; westward from this peak, passing the considerable valley of Goshoot lake, the considerable north and south range, called Wa-ro-ja, rises, the eastern slope and northern end of which are alone visible; to the west of this range Franklin valley opens, and is followed by the Humboldt River mountains, terminating the view in that direction. Intermediate to the ranges named are more or less considerable valleys extending parallel with them, the views of which are obstructed by the mountains themselves; but by a course somewhat winding from the pass on the east, a succession of plains and valleys, broken by the ordinary inequalities of such surfaces, is seen, by which the most practicable rail-road route in the vicinity extends as far west as the eastern slope of the Humboldt mountains. Other views succeed this, showing more of Franklin valley and the pass by which it is proposed to cross the Humboldt mountains to the valley of the river of the same name; and similar views are given of the country where the proposed line of railroad leaves the Humboldt river, and where it ascends and crosses the Sierra Nevada.

To show to what extent our topographical work may be depended upon as correct, I deem it proper to explain the manner of its execution, when it was immediately under my charge, after the experience of the first year's field-work under Captain Gunnison, assisted by Mr. Egloffstein, both in the field and in the office. Proper astronomical observations for the determination of geographical positions, and of the variation of the needle, were, of course, frequently made; the distances traversed were measured by odometers, two being used upon the same trail wherever it was practicable, for comparison, and barometric observations made at regular hours daily, as well as at all considerable changes of level, for altitudes. The party daily proceeded on its duties in such order as circumstances required, it being frequently necessary to locate our trail with accuracy, for a portion of it to keep a greater or less distance in advance of the topographer to enable him to take accurate bearings upon their successive positions on extensive plains, where no trees or prominent objects afford natural marks for this purpose; and to facilitate the taking of back-sights, if possible to discover any local attraction, or other source of error, smokes and camp-fires left behind were often found useful. In connection with the trail the topography adjacent to it was constantly laid down with great care, and the first favorable locality near it assumed for making observations of the country to a greater or less extent, and as accurate profile or outline sketches of it made as our skill enabled us to execute, on which every prominent feature and landmark was noted with especial care, together with their magnetic bearings; and if distant snowy peaks were visible, angles of elevation were taken to the lower lines of snow, the general altitude of this line for the section of country and season of the year being once determined, affording great assistance in estimating the height of all other mountains in the vicinity, and were subsequently used for determining their distances from the point of observation, and the adjacent and middle ground portions were laid down with fidelity. Proceeding, then, for two, three, or four miles upon the trail, the distance, of course, varying with the formation of the country, the topographer again assumed the most favorable position in the vicinity for his purposes, and repeated the labors of the previous hour. In addition to this constant labor along the trail, it frequently, almost daily, became necessary to leave it and make distant side trips, ascending elevated mountain peaks and ridges to obtain correct and distant views of the country, and I cannot speak too highly of the fidelity, zeal, and ability with which Mr. Egloffstein always performed these onerous labors. In starting for such points, forward bearings were, of course, taken, and verified on his arrival by back-sights, and barometers read for altitude, both on his arrival and departure. It is not necessary here to describe the beauty, extent, and grandeur of the scenes which from these positions, in the pure atmosphere of this portion of our country, greeted him, frequently embracing an area equal to that of some of our Atlantic States, and presenting a multitude of plain and mountain outlines,

with snow-capped peaks rising just on the verge of the horizon, and frequently remaining in sight for days, serving as points of reference, and all of which were carefully traced and noted for the delineation of the country. This labor done, those on the trail were resumed and continued to camp, where the mountain curves were filled up with shading lines, and every item of importance to the correct construction of the map recorded; for, in prosecuting for months labors of this kind in a mountainous country, it will not do to trust to the memory for its character on successive days. For field use a continuous map of the country was daily kept up, and the field-work, as here described for a day, was continued to its completion. In entering upon the final construction of the map, in order to eliminate all possible errors in the field-notes, the trail was again laid down continuously from the place of beginning to the terminus of the work, on the same scale (three miles to one inch) with the original sketches, without reference to the true meridian; and separate constructions of all the knots of principal bearings to prominent features of the country were made on tissue paper, which, from its transparency, affords great facility for the comparison of the different constructions of overlapping sheets, and from these the whole was projected on the trail sheet, reconciling as far as possible all discrepancies. Upon the map thus constructed, all reliable latitudes were entered at their respective places, and connecting lines of latitude drawn through the whole work, thereby detecting by these variable curves any remaining inaccuracies in the work itself. Lines of longitude were then drawn, without regard to the singularity of their appearance, as nearly perpendicular to these irregular curves of latitude as possible, great regard being paid, however, in case of too great deviation of lines of longitude from north and south, to the influential bearings towards those portions of the map. This system of detecting the deficiencies of the field-work was carried to divisions of five minutes of latitude and five minutes of longitude. The topographical outline or profile sketches extending to the horizon, heretofore mentioned as taken from elevated positions, and forming circular views, of which the centres are occupied by the observer, were then corrected by all the discovered errors applicable to them, and formed a system of plain table work, which, when the sheets were properly placed on the projected map, overlapped large sections of the same co ntry, and, being on transparent paper, greatly facilitated the construction of the map from their centres, and had the advantage by their profiles of keeping constantly before the draughtsman vivid pictures of the country. This method was followed by Mr. Egloffstein; but these views were subjected by him not only to the bearings and his judgment in their construction, but where the extent of the valleys, the altitudes and distances of the mountains were not determined by traversing and actually measuring them, angles of elevation were taken to the lowest line of snow at the time, and, with the assistance of Mr. J. de la Camp, formulas prepared and tables calculated for determining their distances from the points of observation. Formulas were also prepared by these gentlemen for determining the horizontal distortion of distances in perspective from such altitudes, tables calculated, and the resulting corrections applied not only to the map but to the views. These tables once prepared, a simple reference for a given angle and bearing furnished its locality with great accuracy. Thus, by the first table, if the observer in the Basin be at an altitude of 5,250 feet above the sea, and the observed lowest line of snow at an elevation of 7,500 feet above the sea, and is seen at an angle of $2^{\circ}\ 36'\ 30''$, its distance exceeds nine miles by a small fraction; and, by the second table, if an observed horizontal distance of three miles, of which the nearest point is six miles distant, and the farthest nine miles, be seen from an elevation 2,750 feet above it, it equals 0.02840 of a unit of the scale of the drawing. Scales were also prepared to facilitate the use of these tables.

The table for the mathematical projection of the map, giving the units in statute miles, was calculated to half degrees by the formulas published by the Superintendent of the United States Coast Survey in his annual report for 1853.

As before stated, the most accurate portion of the topography of the map is, undoubtedly, that adjacent to the trails for four or five miles on either side, and which, in its final, as in its preliminary construction, furnished the basis for the difficult construction of the more distant portions.

OF

EXPLORATIONS FOR A ROUTE FOR THE PACIFIC RAILROAD,

OF THE LINE OF THE

FORTY-FIRST PARALLEL OF NORTH LATITUDE.

BY

LIEUT. E. G. BECKWITH,

THIRD ARTILLERY.

1854.

INTRODUCTORY LETTER.

WASHINGTON, D. C., *December* 30, 1854.

SIR: The very limited time left for the preparation of the accompanying report, after completing, on the last of November, that of Captain Gunnison's explorations of last year, has only permitted me to complete it in the most hasty manner.

The outline-map which accompanies it was also made in the greatest haste, but it is believed will be sufficient for the immediate wants of the government. The more finished maps are in course of preparation, and will be transmitted to the department as soon as they can be completed. A geological report of the country explored by Captain Gunnison and myself is nearly complete, and, with the reports upon the plants and specimens of natural history collected during the trip, will be submitted as early as practicable, the drawings for their illustration not yet being complete.

My assistants in the explorations embraced in the accompanying report were Mr. Sheppard Homans, astronomer, by whom the observations and computations for latitude were made, our defective instruments not admitting of observations for longitude; Dr. James Schiel, geologist, who is still engaged upon his report; Mr. F. W. Egloffstein, topographer, to whom I am indebted for superior topographical sketches and the preparation of the accompanying outline map, and who is still engaged in making the elaborate maps of the survey; and Mr. J. A. Snyder, to whom the collection of botanical specimens was intrusted, but who was also constantly employed in making meteorological observations, and who has been employed, since my return, as an assistant in making computations of barometric observations under Mr. Lorin Blodget, by whom they were discussed, and whose notes accompany the tables. For the energy, ability, and cordial co-operation of each of these gentlemen, and of Brevet Captain R. M. Morris and Lieutenant L. S. Baker, of the regiment of Mounted Riflemen, in charge of the escort from that regiment, in the execution of the duties of the exploration, I desire to express my obligations and esteem.

I am, sir, with much respect, your obedient servant,

E. G. BECKWITH,
1st Lieutenant 3d Artillery.

Hon. JEFFERSON DAVIS,
Secretary of War.

CONTENTS.

CHAPTER I.

From Great Salt Lake City east to Green river, and back, by the Weber and Timpanogos rivers, respectively—April, 1854.

Page.

Explorations resumed.—Advance of spring.—Winter of 1853–'54 at Great Salt Lake.—Timber near the city.—Impracticability of the present wagon-road over the Wahsatch mountains in winter.—Winter mail-route.—Weber river; its lower cañon; fine grazing district; condition of cattle grazed during the winter, during which they crossed the mountains.—Cattle-trade in Utah.—Rocks of lower cañon; its passage by railway.—Snows in cañon.—Wagon-road possible from Ben Simon's creek east.—Second cañon of the Weber; its crossings, railroad practicability, and character of its rocks and dikes.—Valley of Weber river from the head of the second cañon to White Clay creek.—Emigrant-road.—Conglomerate sandstone.—Snow.—Character of White Clay Creek valley; game; snow-banks.—Uinta mountains.—Porcupine Terrace.—Timber.—From White Clay creek to Bear river; its character and valley where crossed.—Snow-blindness.—Sulphur creek.—Muddy creeks.—Black's Fork.—Greatest depth of snow encountered.—Extensive view.—Greatest altitude of the line; its railroad practicability.—Black's Fork valley.—Beaver-dams.—Smith's Fork.—Fort Supply.—Fort Bridger.—Railroad route thence eastward.—Snow-storm.—Crossing to Henry's Fork.—Sioux war-party.—Henry's Fork valley.—Ascent of mountain at the end of our eastern course.—General description of the country from this point.—Snow-blindness of party, and of "Ring."—Plains crossed in returning to Smith's Fork.—Black's Fork.—Muddy creek.—Bear river.—White Clay creek.—Nests of edible bugs.—Attempt to find a direct passage to Kamas prairie.—Mountains and fields of snow encountered.—Country seen from mountain summit.—Impracticability of continuing the passage.—Timber.—Return to White Clay creek and Weber river.—Fine grass-fields.—Impracticability of this route for roads.—Rocks and soil.—Weber River valley above White Clay creek.—Kamas prairie.—Timpanogos river.—Round prairie.—Timpanogos cañon; its railroad practicability.—Utah Lake valley.—Railroad line *via* the foot of the Lake and Cedar valley, or by the valley of the Jordan and north of Oquirrh mountains.—Return to Salt Lake City - - - - - - - - - - - - 9

CHAPTER II.

From Great Salt Lake City to the valley of Humboldt river—May 1 *to* 23, 1854.

Receipt of orders.—Explorations performed in anticipation of the receipt of these orders, and extract therefrom.—Leaving Salt Lake City.—Valley of the Jordan.—Grass and springs.—Railroad line by the south end of Great Salt Lake.—Snow-storm.—Scenery in entering Tuilla valley.—Mormon settlements.—Old shore-line.—Formidable pass.—Goshoot Indians.—Indian guides.—Salt and warm springs.—Character of rocks.—Water driven over marshes of the lake.—Birds.—Springs in conglomerate rocks.—Fish.—Spring or Lone Rock valley.—Frémont's route of 1845, and Stansbury's of 1849.—Railroad route.—Gophers and grass-seed as Indian food.—Passage of Cedar mountains.—Scarcity of water.—Pass not suitable for a railway.—The Desert to Granite mountains and Fish springs.—Storms.—Mirage.—Railroad route to the south and west of Pilot Peak.—Miserable condition of Goshoot Indians.—Examination of first range of Goshoot mountains.—Rocks; grass; timber.—Fish creek.—Railroad route.—Shoshonee Indians.—Striking contrast between the Shoshonees and Diggers, (Goshoots).—Passage of successive ranges of Goshoot mountains.—Vegetation and rocks.—Gate of Narrow Pass.—Rain; hail; springs.—Wretched condition of Indians.—Frost.—Goshoot lake.—Digger wick-ey-up and its occupants.—Digger language.—Topographical sketches of railroad line *via* Pilot Peak.—Franklin River valley; its lakes, rivers, and vegetation.—Old lake-shore.—Hastings's road.—Route for packing-parties.—Pilot Peak railroad line.—Remarkable formation of the basin.—Humboldt Mountain railroad pass.—Country as seen to the west of this pass.—Snow in the pass.—Rocks in the pass.—Valley of the Humboldt, by Colonel Frémont - 20

CHAPTER III.

From the valley of Franklin river, east base of the Humboldt mountains, to the crossing of the Humboldt river—May 24 *to June* 9, 1854.

Page.

Journey along the eastern base of the Humboldt mountains.—Forty hot springs.—Mountain chiefly granite.—Eclipse of the sun.—Lakes.—Shore-lines.—Digger Indians.—Fevers.—Numerous springs.—Outlet of subterranean river.—Passage of the Humboldt mountains to the southern branch of Humboldt river.—Interior or secondary basin.—Digger methods of catching gophers and marmots.—Indian singing, lodges, and wardrobes.—Quartz mountain.—Agate Pass.—Rheumatic fevers.—Snow-storm.—Difficult mountain passage.—Lake and miry plain.—Edible roots.—Return to proposed railroad line.—Description of the valley of the Humboldt.—Character of the vegetation of a large portion of the country between the Rocky mountains and the Sierra Nevada.—Humboldt river.—Bad character of its water and grass.—Cause of the loss of stock; how avoided - - - - - - - - - - 30

CHAPTER IV.

From the crossing of Humboldt river, via the Madelin Pass, to the junction of Fall river with the Sacramento, and back to the shore of Honey lake, eastern base of the Sierra Nevada—June 10 *to July* 4, 1854.

Crossing Humboldt river.—Droves of cattle and sheep.—Lassen's meadows, and termination of the western course of the Humboldt river.—Country and passages to the west.—Willows and water.—Mud lakes.—Noble's road.—Railroad grades.—Mud lakes, or plains and deserts; their passage.—Frémont's trail of 1844.—Similarity in geological character of some of the mountain spurs and plains.—Examination of the Sierra Nevada; their broad, massive, and terrace character.—Marshes, ponds, and stony surface.—Indians.—Madelin Pass examined.—View of Mount Shasta.—Grades and altitude of pass.—Country southeast of the broad plains of Madelin Pass.—Light, miry, and stony soil.—Indians.—Basin character of the broad plains of the summit of the Sierra.—Game.—Error in location of Feather river in the best authenticated maps.—Forests.—Descent to Round valley; waters of the Sacramento.—Practicability of this descent for a railway.—Indians, (Pah Utahs?).—Grave.—Emigrant road (Lassen's) and Oregon road.—Source of the Sacramento; its first cañon.—Grades.—Pitt river; Pah-Utah or Digger Indian women digging roots.—Making arrow-heads.—Indian pantomime.—Impracticability of descending the Sacramento with wagons; its examination to the mouth of Fall river.—Second cañon of the Sacramento.—Impassable volcanic rocky fields.—Character of the river banks.—Timber.—Grades.—Reference to itinerary, from July 15 to 21, for a description of the Sacramento below Fall river.—Recrossing the Sierra Nevada.—View of peaks of the coast range.—Graves of emigrants.—Pine creek.—Noble's Pass road.—Summit creek.—Susan river.—Eagle lake.—Roop's farm in Honey Lake valley - 36

CHAPTER V.

From the valley of Mud lake, via Honey lake and Noble's Pass, to Fort Reading, at the junction of Cow creek with the Sacramento river, California—July 5 *to* 12, 1854.

From Mud to Honey and Pyramid lakes.—Honey Lake valley.—Noble's road.—Boiling springs.—Northern limit of the sources of Feather river.—Reascending the Sierra Nevada *via* Susan river.—Plain from Summit to Pine creek.—Character of the mountain from Susan river to Pine creek.—Grades.—Broad trunk of the mountain.—From Pine creek to Black Butte creek.—Grades.—Country directly west from camp on Black Butte creek; its impracticability for roads.—Ascending Black Butte creek.—Lava field.—Black Butte.—Distribution of sand.—Grades.—Hat creek.—Head of Canoe Creek valley.—Line west from Hat creek.—Crossing Wolf creek to the western summit of the Sierra Nevada.—Grades.—Western descent of the Sierra.—Battle creek.—Deer flats.—Hill's rancho.—McCumber's mill.—Shingletown.—Narrow ridge and steep descent.—Table of grades and altitudes.—Difficulties of the pass for a railroad.—Arrival at Fort Reading - - - - - - - - - - - - - - - - 47

CHAPTER VI.

Ascent of the Sacramento river from Fort Reading to the mouth of Fall river, (line of the Madelin Pass,) and thence by the valley of Canoe creek to Noble's Pass, and return to Fort Reading—July 15 *to* 26, 1854.

Character of the Sacramento valley above Fort Reading.—Mining village.—Sacramento river enclosed by mountains; its character.—Trail to Yreka.—Stream known as the Sacramento.—McCloud's Fork.—Salmon.—Pittsburg ferries.—Snows and freshets.—Ascent of the river.—Rapids.—Hot spring.—Re-ascent of mountain.—River still shut in by precipitous mountains.—Valley at the mouth of Canoe creek.—Second cañon of the Sacramento; its character.—Table of grades from Fall river to Fort Reading.—Completion of the survey of Madelin Pass.—Return to Black Butte creek, Noble's Pass.—Numbers of Indians daily seen.—Fields of lava.—Valley of Canoe creek; difficulty of its passage.—Disappointed in the course of Black Butte creek.—Night march.—Return to Fort Reading.—Sacramento valley.—Party disbanded - - - - - - - - - - - - - - - - 54

CHAPTER VII.

General summary and railroad practicability of the line explored on the forty-first parallel of north latitude.

Page.

Railroad connexion east from Fort Bridger.—Valley of Green river.—Grazing cattle in winter in the mountains.—Mormon settlement on Smith's Fork.—Bear River, Wahsatch, and Uinta mountains.—Highest point of the line reached.—Appearance of the country thence west.—Depth of snow.—Timber, soil, and grass.—Length of line from Smith's Fork to Oquirrh mountain.—Cañones of the Weber and Timpanogos rivers.—Railroad in the Jordan, Tuilla, and Lone Rock valleys.—Mormons desirous to aid in the construction of the road; their numbers.—Cedar mountain.—The Desert.—Passages to the south of Pilot Peak, and thence to the Humboldt mountains.—Humboldt Mountain Pass; its altitude.—Timber and its abundance.—Valley of the Humboldt river.—Country south of this valley; its profile.—From Humboldt river to the foot of the Sierra Nevada.—Fertility of this section.—The ascent of Madelin Pass; its altitude; broad plain at its summit.—Highest point of the pass; its western descent; timber, and soil.—Round valley.—Sacramento river.—First cañon of the Sacramento.—Second cañon of the Sacramento.—The Sacramento below the mouth of Fall river.—Noble's Pass of the Sierra Nevada.—Mud lakes to Honey lake.—Honey Lake valley.—Ascent of the mountains.—Susan river.—Pine creek.—Black Butte creek.—Black Butte.—Hat and Wolf creeks.—Greatest altitude in this pass.—Descent from the western summit of the Sierra.—Depth of snow in winter in this pass.—Dr. Wozencraft's observations.—Entire length of the pass.—Head of steamboat navigation of the Sacramento.—Future surveys.—Method of determining levels.—Building-stone upon the route.—Water.—Cultivable land.—Directness of this line: its length - - - - - - - - - - - - - - - - 59

CHAPTER VIII.

I. *Table of distances and of approximate average grades per mile upon the line explored for a railroad from Smith's Fork, near Fort Bridger, in the valley of Green river, Utah Territory, via the Madelin Pass, to Fort Reading, in the valley of the Sacramento river, California*—1854 - - - - 7

II. *Table of distances, and of approximate average grades per mile, upon the line explored for a railroad from Mud lake, via Noble's Pass, to Fort Reading, July* 4 *to* 26, 1854 - - - - 69

III. *Table of latitudes on the line of the forty-first parallel of north latitude, explored for the Pacific railway*, 1854 - - - - - - - - - - - - - - - - 70

CHAPTER IX.

I. *Introduction to meteorological table, and table of altitudes and distances, on the line of the forty-first parallel of north latitude explored for the Pacific railroad* - - - - - 71

II. *Meteorological table at Great Salt Lake City during the winter of* 1853–'54 - - - - 77

II. *Summary of meteorological observations at Great Salt Lake City in* 1853 *and* 1854, *in mean results at each observed hour for the several months; barometric reading corrected for temperature* 83

V. *Barometric means for the months observed at Great Salt Lake City in* 1853–'54, *from all the observations, including those at irregular hours, and corrected in detail for horary variation of pressure* 83

V. *Meteorological observations, and table of altitudes and distances, from Great Salt Lake City to Green river, April*, 1854 - - - - - - - - - - - - 84

VI. *Data for profile from Smith's Fork, Green River valley, to that of Great Salt lake, via the Timpanogos river* - - - - - - - - - - - - - - 86

VII. *Data for profile from Great Salt Lake valley, via the Weber river, to White Clay creek; the preceding profile being in common with this from the latter point eastward* - - - - - 86

VIII. *Meteorological observations, and table of altitudes and distances, from Great Salt lake, Utah Territory, to the valley of the Sacramento river, California*, 1854 - - - - - - 87

IX. *Meteorological observations and table of altitudes, from Mud lake, via Mud creek, to the summit of the Sierra Nevada, and to Madelin Pass; table not used in profile* - - - - - 90

VIII. *Continuation of Table* VIII - - - - - - - - - - - - - - 91

X. *Meteorological observations and table of altitudes, in crossing from Madelin to Noble's Pass, on the summit of the Sierra Nevada; table not used in profile* - - - - - - - 92

VIII. *Table* VIII *again resumed* - - - - - - - - - - - - - 93

XI. *Meteorological observations and table of altitudes and distances for profile, from Mud lake to Fort Reading, on the Sacramento river, California, via Noble's Pass* - - - - - 93

XII. *Meteorological observations and table of altitudes, on the road leading through Noble's Pass* - 95

XIII. *Meteorological observations and table of altitudes, in crossing from the mouth of Canoe creek (Poinsett river) to Black Butte creek, and thence west to Hat and Wolf creeks; table not used in profile* - - - - - - - - - - - - - - - 95

CHAPTER X.

Page.

I. *Geological report of the country explored under the 38th and 41st parallels of north latitude in 1853–'54, by James Schiel, M. D., geologist for the expeditions* - - - - - - - - - - 96
II. *Letter from Professor J. W. Bailey, upon infusorial fossils submitted to him by Dr. Schiel* - - 111

APPENDIX.

Instructions from the Secretary of War - - - - - - - - - - - - 113

ERRATA.

Page 77.—Under the head of Corrected Barometer, No. 551, observation of December 12, at 12 o'clock m., for 25. 713, read 25. 613.

Page 77.—Under the head of Corrected Barometer, No. 496, observation of December 12, at 3 p. m., for 25. 768, read 25. 668.

Page 80.—Under the head of Corrected Barometer, No. 551, observation of February 21, at 9 a. m., for 25. 698, read 25. 598.

Page 80.—Under the head of Corrected Barometer, No. 551, observation of March 3, at 9 a. m., for 25. 758, read 25. 658.

Page 87.—Under the head of Corrected Barometer, No. 551, observation of May 8, at sundown, for 25. 758, read 25. 658.

ADDITIONAL ERRATA.

Page	44	----------	3d	paragraph,	1st	line,	for	8. 95	read	4. 60
"	"	----------	"	"	"	"	"	34. 80	"	68.
"	57, Table,		2d	column	2d	"	"	8. 95	"	4. 60
"	"	"	3d	"	"	"	"	8. 95	"	4. 60
"	"	"	4th	"	"	"	"	35.	"	68.
"	64	----------	2d	paragraph,	5th	"	"	8. 95	"	4. 60
"	66	----------	4th	"	9th	"	"	1011. 71	"	1007. 36
"	"	----------	"	"	11th	"	"	1899. 71	"	1895. 36
"	69, 1st Table,		2d	column	4th	"	"	8. 95	"	4. 60
"	"	"	3d	"	4th	"	"	895. 41	"	891. 06
"	"	"	"	"	5th	"	"	900. 11	"	895. 76
"	"	"	"	"	6th	"	"	922. 61	"	918. 26
"	"	"	"	"	7th	"	"	930. 11	"	925. 76
"	"	"	"	"	8th	"	"	956. 61	"	952. 27
"	"	"	"	"	9th	"	"	961. 31	"	956. 96
"	"	"	"	"	10th	"	"	971. 81	"	967. 46
"	"	"	"	"	11th	"	"	977. 06	"	972. 71
"	"	"	"	"	12th	"	"	988. 81	"	984. 46
"	"	"	"	"	13th	"	"	1011. 71	"	1007. 36
"	93	"	4th	"	5th	"	"	8. 95	"	4. 60
"	"	"	5th	"	5th	"	"	801. 64	"	797. 29
"	"	"	"	"	"	"	"	806. 34	"	801. 99
"	"	"	"	"	"	"	"	828. 84	"	824. 49
"	"	"	"	"	"	"	"	836. 34	"	831. 99
"	"	"	"	"	"	"	"	862. 84	"	858. 49
"	"	"	"	"	"	"	"	867. 54	"	863. 19
"	"	"	"	"	"	"	"	878. 04	"	873. 69
"	"	"	"	"	"	"	"	883. 29	"	878. 94
"	"	"	"	"	"	"	"	895. 04	"	890. 69
"	"	"	"	"	"	"	"	917. 94	"	913. 59

REPORT.

CHAPTER I.

From Great Salt Lake City east to Green river, and back, by the Weber and Timpanogos rivers, respectively—April, 1854.

Explorations resumed —Advance of spring.—Winter of 1853–'54 at Great Salt Lake —Timber near the city.—Impracticability of the present wagon-road over the Wahsatch mountains in winter.—Winter mail-route.—Weber river; its lower cañon; fine grazing district; condition of cattle grazed during the winter, during which they crossed the mountains.—Cattle-trade in Utah.—Rocks of lower cañon; its passage by railway.—Snows in cañon.—Wagon-road possible from Ben Simon's creek east.—Second cañon of the Weber; its crossings, railroad practicability, and character of its rocks and dikes.—Valley of Weber river from the head of the second cañon to White Clay creek.—Emigrant-road.—Conglomerate sandstone.—Snow.—Character of White Clay Creek valley; game; snow-banks.—Uinta mountains.—Porcupine Terrace.—Timber.—From White Clay creek to Bear river; its character and valley where crossed.—Snow-blindness.—Sulphur creek.—Muddy creeks.—Black's Fork.—Greatest depth of snow encountered.—Extensive view.—Greatest altitude of the line; its railroad practicability.—Black's Fork valley.—Beaver-dams.—Smith's Fork.—Fort Supply.—Fort Bridger.—Railroad route thence eastward.—Snow-storm.—Crossing to Henry's Fork.—Sioux war-party.—Henry's Fork valley.—Ascent of mountain at the end of our eastern course.—General description of the country from this point.—Snow-blindness of party, and of "Ring."—Plains crossed in returning to Smith's Fork.—Black's Fork.—Muddy creek.—Bear river.—White Clay creek.—Nests of edible bugs.—Attempt to find a direct passage to Kamas prairie.—Mountains and fields of snow encountered.—Country seen from mountain summit.—Impracticability of continuing the passage.—Timber.—Return to White Clay creek and Weber river.—Fine grass-fields.—Impracticability of this route for roads.—Rocks and soil.—Weber river valley above White Clay creek.—Kamas prairie.—Timpanogos river.—Round Prairie.—Timpanogos cañon; its railroad practicability.—Utah Lake valley.—Railroad line *via* the foot of the Lake and Cedar valley, or by the valley of the Jordan and north of Oquirrh mountains.—Return to Salt Lake City.

SIR: Explorations were resumed on the 4th of April, 1854, for a route for the Pacific railroad under my direction, by the surviving portion of Captain Gunnison's party, (which had wintered at Great Salt Lake City,) under the original instructions given to that officer to explore the most available passes and cañones of the Wahsatch range, and cross the Weber and Bear rivers to the coal basin of Green river, and thence proceed to Fort Laramie.

Leaving the city, we proceeded north along the shore of the lake, passing through the Mormon settlements and farms, which occupy the most fertile and best watered sections of the narrow belt of land lying between the shore and the base of the mountains. Spring was already considerably advanced in the valley; fresh grass and plants were springing up on its sunny slopes; farmers were busy in ploughing and sowing their fields, and the snow had disappeared to such an extent on the sides of the mountains, that it was deemed practicable for our animals to subsist upon the dry grass of the previous year's growth.

The winter of 1853–'54 at Great Salt lake, from the middle of November to the 20th of January, was delightfully mild and open, and the fall of snow, which was light in the mountains, seldom extended into the valleys; but after the latter date the climate became much more severe, the temperature falling during the colder part of the day, for several successive days, below zero of Fahrenheit's thermometer, and storms became more frequent—snow falling in the plain to the depth of six or eight inches without drifts, while in the mountain plains and passes it exceeded a foot, and accumulated to great depths in the narrow ravines, and on the high slopes of the mountains, least exposed to the winds. In the vicinity of the city of the Great Salt Lake timber is confined almost exclusively to these ravines, which are difficult of

access at all times, and become entirely inaccessible during the prevalence of deep snows, producing at once great scarcity of fuel in that city. The passage of the uninhabited mountain to the east, at such times, by the ordinary road leading over it, which, of course, is not kept open, is entirely impracticable; and the mail which passes monthly to and from Independence, Mo., is carried on pack-mules, which subsist themselves almost entirely on the grass along the route, by way of the Weber river cañon—the object in part of our present explorations, which will, however, be continued eastward to the valley of Green river.*

April 5.—On the afternoon of the fifth of April we reached the mouth of this cañon at the immediate base of the Wahsatch mountains, where it opens into the valley of Great Salt lake, thirty miles north of the city, and about seventeen from the mouth of the river, which we immediately crossed to its right bank. This river at this season of the year (not yet swollen by the melting snows of the mountains) is thirty yards wide, by from one to three feet in depth, flowing with a rapid, powerful current over a bed of water-worn stones and fallen rocks of all sizes, from pebbles to immense blocks of the adjacent mountain. Our altitude at this point was 73 feet above the city of Great Salt Lake, and 4,424 feet above the sea. Entering the pass, we at once left the usual low-water trail, which frequently crosses the river, and followed a precipitous and rocky path leading over the retreating craggy sides of the cañon, so steep that a single mis-step would have precipitated both mule and rider into the foaming torrent, hundreds of feet below us. At some points the precipitous sides of this passage become almost vertical. The mountains rise, we judged, from 1,500 to 2,500 feet above the river, and are separated at the base by a passage averaging 175 yards in width, in which the river winds from side to side, frequently impinging against the the bases of the mountains. At one point only, near the upper end of the gorge, which is four miles in length, the river is narrowed to one half its usual width, having cut a passage 20 or 30 feet in depth through the solid rock, which on the north side overhangs the stream, which, by a low projecting mass, is deflected from its course for a few yards at nearly a right angle, but again almost immediately resumes its direction; the cañon, as it is called—and at some points it well deserves the name—being remarkably direct in its general course. Above this gorge the mountain opens rapidly to the right and left,

* One of the most striking features to the traveller in our extensive and inhospitable interior country, after reaching the Rocky mountains from the east, in whatever direction he may travel in it, is the vast field of mountains which everywhere meets the eye. These mountains are sometimes formidable and united, their summits perpetually enveloped in snow, but more generally broken and disconnected, or partially united by projecting spurs or low connecting ridges, retaining snow but a portion of the year. They conform, with considerable exceptions, but not sufficient to impair its generality, in their greatest length to a general northern and southern direction, but frequently varying many degrees from the meridian. The great Rocky mountain range, by the line of our last and present years' explorations, consists, towards the east, of the Sierra Blanca range, in which are the passes of the Sangre de Cristo, and of Roubideau and Williams, united at the head of the San Luis valley with the Sierra San Juan; or at this point the range may be said to divide the two branches, under different names, extending far to the southward, enclosing the valley of the Rio Grande del Norte; the western or San Juan range eventually becoming the Sierra Madre of Mexico. Northward from the Sierra Blanca, the range is more or less broken by the valley of the Arkansas river, but preserves its general course, surmounted by Pike's and Janes' peaks, to the Cheyenne and Bridger's passes, and thence to the South Pass, where, nothwithstanding the great elevation of the country, its mountainous appearance is in a great measure lost, although the country is still very hilly and rolling, and in the distance high mountain peaks are ever visible. North of the South Pass, for some distance, the Rocky mountains again become lofty and again branch, sending out to the south a formidable range, known in various portions under different names, but generally as the Bear river and Wahsatch range, broken by the passage of Bear, Weber, Timpanogos, and Sevier river in their western course, but enclosing to the west the valley of Green river. Thus these three ranges, with their spurs and connecting ridges, form, on the line of our explorations, the main features of the Rocky mountains. But the country to the west is scarcely less mountainous; and as we become familiar with it in pursuing our explorations in various directions, it presents to our minds *one vast field of mountains*, interspersed with arid valleys from the Rocky mountains to the Sierra Nevada, and from the British possessions far southward into Mexico. The most extensive valley susceptible of cultivation in this whole extent of territory is that occupied by the Mormons, which is supplied with water for irrigation by the extensive fields of perpetual snow which are found on the mountain summits in their vicinity. And I may observe, generally, that fields of perpetual snow, affording an unfailing supply of water for irrigation, are an indispensable pre-requisite for their cultivation, and hence for their occupation, whatever may be the character of the soil of the valleys, in every portion of this territory in which I have travelled—a district extending from the northern boundary of Mexico to the waters of the Columbia river, and, by different routes, from New Mexico and the Arkansas river to the Sierra Nevada.

forming an immense oblong amphitheatre, the summits of the mountain peaks on opposite sides being separated by from 10 to 15 miles, while the river bottom, which is a plain, varies in width from half a mile to three miles. This is the finest grazing district we have seen in Utah, the bottom being covered with luxuriant grass which extends well up the mountain sides, to where they are at present covered with snow. The stream is skirted with poplar or cotton-wood trees and willow-bushes, and limited amounts of cedar, fir, and pine adorn the ravines and mountain sides, but are difficult of access. We encamped, after a march of 27 miles, at the junction of Ben Simons' creek with the Weber, where we found our Delaware guide, (after whom the creek is named,) with his brother and their respective squaws and little Indians encamped, with a small band of horses and herd of cows grazing near their lodges. These cattle appear in fine condition, having subsisted here through the entire winter by grazing alone. A much larger herd ot cattle, on their way to the California market, which had been grazed in the vicinity of Fort Bridger during the early part of the winter, were subsequently driven here, where they remained for several weeks, having left but a day or two previous to our arrival. A considerable trade is carried on in cattle in and near the valley of Great Salt lake; its main profit arising from the exchange of cattle in good condition for those of emigrants broken down on their arrival here, compelling an exchange or a ruinous delay in their journey to California. The stock obtained by this traffic is turned out to graze during the winter; and although a few of the weakest and most emaciated die of cold, the great body of them come out in fine condition in the spring, and are sent forward to the California market, or form a new stock in trade for the ensuing season.

Our average ascent from the mouth of the cañon to camp, 7.80 miles, has been 53.50 feet per mile. The rocks in the gorge partake largely of the character of gneiss; but in descending the river with a railroad, no unusual difficulty would be encountered at this point, as the walls of the pass are sufficiently retreating to admit of its being carried at a suitable height above the stream to escape the danger of floods, and extensive blasting of rocks would be required only at a few points. Snows have formed no obstruction to its passage at any time during the past winter, nor, so far as I have been able to learn after much inquiry, do they at any time. In the valley, at our guide's camp, its greatest depth during the last winter was twelve inches, but seldom exceeded four, and for much of the winter was quite as free of it as the main valley of Salt lake. Our guide thinks a much more favorable emigrant road could be opened through this pass, ascending Ben Simons' creek to the vicinity of Green river, than that now followed over the mountains, which is still impassable from snow.

April 6.—We traversed the amphitheatre described yesterday, following the bottom lands along the Weber river to the foot of the second mountain and gorge of this stream, our ascent being 28.50 feet per mile for 12.20 miles, to Sheep Rock. The sides of this gorge are less precipitous than those of the lower, and the bottom or passage in which the river winds is frequently much wider, while the mountains are of nearly the same altitudes with those, but much more broken by ravines. The bottom, too, is less firm, being frequently miry, and numerous small channels into which the river is divided are dammed by beaver—green trees of six inches in diameter having just been cut down by these animals for their damming purposes—making part of it a swamp, miles of which are covered with thick willows, where the soil is too soft for a good wagon road without carrying it on an artificial bed, which can be easily made along the base of the mountains. The river winds so much that we were forced to cross it sixteen times, the water being icy cold. We encamped on Dry creek, which enters the river at the head of the gorge, eight and a half miles from Sheep Rock, from which we ascended 27 feet to the mile. In constructing a railroad through this defile, it will be necessary to bridge the stream several times, which can be readily done; but for the most part the road would be carried immediately at the base of the mountains, where it can be constructed with facility by cutting along their sides and filling in at their bases. These bases are formed of earth and loose stones overlying strata of shale, limestone, conglomerate, and argillaceous sandstone, dipping at every

angle, and in almost all eastern directions from south to north; and in a few instances strata bent (before induration) were seen; and in one, vertical, parallel, walled dikes intersect the northern slope of a mountain near the head of the passage, extending from the water's edge to near the summit of the mountain, only separated by about ten feet, and rising thirty feet above the mountain slope.

April 7.—A cold rain, which continued to fall throughout the night, poured down upon us as we wrapped ourselves in our blankets last evening; and as we were without tents or other protection from the weather, but little sleep refreshed the party; and at 9 o'clock this morning the rain changed to snow, (which had been falling all night on the high peaks in the mountains,) and continued to fall heavily throughout the day, melting as it reached the ground.

Above the junction of Dry creek with the Weber river, the latter comes from the south, cutting through a red conglomerate sandstone mountain six or eight hundred feet high, which is rapidly disintegrating, the talus at some points being entirely swept away by the river, and at all others it stands at too steep an angle towards the water to be easily climbed over.

The Indian trail, however, passes through this cañon at low water, a part of the way in the stream. It is five hundred yards long. We rode to its upper end and clambered in to examine it. The trail by which we passed ascends Dry creek half a mile, and then passes without difficulty to its head, by a low pass in the ridge through which the cañon itself is cut. This is the proper site, also, for a railroad. Above this cañon a considerable valley extends south to the Kamas prairie. This valley varies in width from three or four miles to a few hundred yards, and is drained by the Weber river, having on its margins considerable bottom lands, which at this season of the year are quite wet, and in many parts are covered by cotton-wood trees and willow-bushes. Ascending this valley we came to the emigrant road leading from the South Pass to Great Salt lake, which we followed to the mouth of Echo cañon, where we left it and continued up the river to the mouth of White Clay creek (Moran's fork.) The mountains on the left of the valley, as we ascended it, are conglomerate sandstone, full of cavities numerously inhabited by ravens. The snow was falling so fast that we were unable to see a hundred yards, and were obliged to dismount and wait for it to diminish; when we again remounted, and, turning east, left the Weber river to ascend White Clay creek and pass over to Bear and Green rivers. The valley of our path after leaving the Weber was from one-half to three-fourths of a mile in width, finely covered with dry and green grass, the hills being covered with a stunted growth of cedar, and cotton-wood and willows line the stream, which has upon it little or no bottom land. The storm ceased as we encamped, having travelled but 10.50 miles, with an average ascent of 16.50 feet per mile.

April 8.—A piercing cold wind sprang up during last night, the thermometer falling to 27°, and continued all day blowing from E.N.E. directly in our faces as we ascended White Clay creek, which is one foot in depth and five in width, with a free rapid current. Its narrow bottom is from one to two hundred yards in width, with low spurs of hills occasionally extending to the stream. It is lined with cotton-wood and willows in the lower part of its course, but is quite destitute of timber higher up, while scattered cedars are seen on the nearest hills, and pine, fir, and aspen fill the ravines of the mountains, the highest peaks of which are 14 miles south of us on the northern bank of Weber river, whence it descends from the east to Kamas prairie. Numerous tracks of grizzly bears and porcupines were seen in the snow, beaver dams and lodges in the creek bottoms, and a fine silver-gray fox watched our progress for some time from a high hill, safely beyond gun-shot. Fourteen miles out we came into continuous fields of snow, six inches in depth, except on the southern exposures, where it had almost entirely disappeared. Its surface was hard and stiff, though not strong enough to bear either men or animals, and as we broke through at every step, our progress was tedious and fatiguing; and these were greatly increased whenever we had to pass slight inequalities in the ground filled with snow, and the narrow drifts always accumulated on the northeastern declivities of the hills —our mules literally rolling, pitching, tumbling, and floundering through. Thermometer at

noon 38°. For the benefit of our animals, we ascended the side of a hill, where the snow had disappeared, on a branch of White Clay creek coming in from the southeast, and encamped just before sundown on a soft, muddy soil, sprinkled with dry grass. The Uinta mountains, whose general course is apparently nearly due east and west, have been plainly in sight for the last two days, some 25 miles south of our path, with numerous high peaks covered with vast fields of snow from the lowest points visible on them to their summits, the sources of the Uinta, Timpanogos, Weber, and Bear rivers, and of Black's fork, and numerous smaller streams. From the northern foot of this range to our path, a level, timbered terrace country extends, called, in the Sho-sho-nee or Snake language, Yaw-ning-got-it, or Porcupine terrace; from the west it extends from the sources of the White Clay creek, (To-sho-sho-coop, in the Snake tongue,) across Bear river, the Muddy and Black's fork, broken only by a few low detached hills and the ravines of the water-courses. Its timber, pine and fir, is abundant, and of a suitable size for bridges and building purposes.

For the first ten miles this morning our ascent averaged 84.20 feet per mile, and 54.20 feet per mile for the following 8.75 miles, to the junction of the branch on which we encamped, with White Clay creek.

April 9.- A bright clear morning; thermometer at daylight 21° below the freezing-point. We returned to White Clay creek, striking it near its head, by passing over the hill on which we had encamped, a distance of 11.50 miles, by the windings of that stream, from the junction of the branch where we left it to encamp, which we examined in repassing this point on our return trip on the 18th instant. This creek preserves its open character, with easy, gentle curves, to its source, the grade averaging 41.80 feet per mile, and the country becoming more level and open as we ascend. We were here upon the divide between the waters of Weber and Bear rivers, immediately overlooking the latter stream a mile and a half distant and but a few feet below us, our altitude being 7,491 feet above the sea.

We immediately descended to the first channel of Bear river, which is forty feet wide and one deep, with a firm bed, crossed without difficulty to a large level plain, four or five miles wide by ten or twelve in length, extending southward to the foot of Porcupine terrace, through which the river winds in a narrow ravine. The snow upon this plain was from six to ten inches in depth—hard and stiff, but not sufficiently so to bear our animals—with pools of water and soft ground beneath it, affording no firm footing, and our progress was consequently very laborious. The sun was very bright, and its powerful reflection from the snow very severe upon our eyes. Three miles from the first we crossed the second channel of Bear river, a small stream four feet wide, beyond which we rose a bluff 12 or 15 feet high, to a second plain extending to our camp on Sulphur creek, which descends in a small ravine from the terrace above. Altitude, 7,494 feet.

April 10.—A light snow begun to fall during last night, and continued all day, with a high, driving wind, which rendered our progress very disagreeable; and nearly one half the officers and men of the party were so snow-blind as to be unable to see beyond a few feet, and suffered intense pain from their inflamed eyes, the lids of which were swollen to a dropsical appearance, while their faces were quite as badly inflamed, skinned, and intensely sore. We crossed a small stream running into Bear river, four miles from our morning camp, and afterwards three small branches, which unite and form the Little Muddy, and encamped on the main creek of that name, after a march of only 11.20 miles. Our altitude on the divide, between Bear river and the Muddy, an affluent of Black's fork, which flows into Green river, and consequently upon what is called the eastern rim of the Great Basin, was 8,133 feet, and at our camp this evening 7,779 feet above the sea.

We encountered but little snow on the high surfaces and western slopes of the hills to-day, but invariably found large drifts just below the crests of the northeastern slopes, occasionally so compact as to bear our animals, but generally giving way under their feet.

April 11.—Thermometer at 5 a. m., 26°. Soon after leaving camp we crossed a small branch

of the Muddy, and then ascended the ridge setting down from the Porcupine terrace, and nearly on a level with it, between the Muddy and Black's fork. This ridge preserves its elevation for several miles to the north, and then subsides abruptly into the valley of the fork. Upon this divide we encountered much more snow than upon any other part of the route, for the warmth of the season was not yet sufficient to affect it at all; and its average depth was from twelve to sixteen inches, while the drifts were broader and deeper than we had before encountered, varying from fifty and a hundred yards to a fourth of a mile in width. These banks, as before stated, are always found just below the northeastern crests of hills and ridges, and can only be avoided by passing either above or below them.

The view from this position is very extensive. Overlooking the immense valley of Green river, which sweeps off to the east, apparently in an almost uninterrupted plain, the Sweet Water mountains near the South Pass, with the positions of the Muddy and Bitter creeks descending from them, are plainly in sight; and to the south the sources of Black's, Smith's, and Henry's forks, in the Uinta mountains.

From the head of White Clay creek, eastward for 19 miles, a railroad should be carried on a gentle curve to the southward, (as indicated on the accompanying map) along the Porcupine terrace before described, crossing Bear river and the main branches of Muddy and Sulphur creeks, where they are narrow ravines, offering no serious obstacles in themselves to its easy construction; thus avoiding any but a local descent in the passage of these streams, and turning all the smaller ravines and branches which must otherwise be crossed below.

The ascending grade upon this line will be 49.8 feet per mile for 12.90 miles, and 39.50 feet per mile for 6.10 miles; and the altitude of the point thus gained—the highest upon the line—8,373 feet above the sea. And in descending from this point, the road should follow the ridge or divide west of the main branch of Black's fork by a uniform grade, to which there is no obstruction, of 40.30 feet per mile for 12.25 miles, to the main open valley of the fork, to which we descended at 10'clock a. m. The level valley of this stream is here three miles in width, with pine, white cedar, and aspen growing upon the stream, and extending to and uniting with that on the base of the Uinta mountains. We found considerable grass in this valley, and mud in place of snow. The stream in the present low stage of the water, the snow not having commenced to melt in the high mountains, is but 12 feet wide and eight inches deep, flowing rapidly over a bed of stones. In crossing its bottom we rode for some distance on the remains of a beaver dam, precisely resembling a small embankment 18 inches high, thrown up in making a common ditch. It is several hundred yards long. Travelling partly parallel to the stream, we crossed over to Smith's fork, which is separated from Black's only by a plain common to them both, passing near a settlement called Fort Supply, commenced on Smith's fork last autumn. It consists of only a half dozen log-houses, and although the margins of the stream are finely grassed—upon which considerable herds of cattle have been successfully grazed during the past winter, with no other food or shelter than they could themselves procure—it must be regarded as a doubtful experiment, until experience shall have established the practicability, in this latitude upon our continent, of producing crops during the cold summers, and grazing cattle during the severe winters, incident to so great an elevation—7,254 feet, that of our camp on the stream, two or three miles below the fort. Our descent from where we came upon Black's fork to camp, nine miles, was 69.50 feet per mile.

We were here in the immediate vicinity of Fort Bridger, the position of which a few miles to the north, on Black's fork of Green river, was plainly in sight across the open plain. In descending from the head of the Muddy I have given the prefere ce to the line indicated, over that which follows that stream, as it is entirely free from short curves; and the valley of Black's fork, above the junction of the Muddy, is much more broad, open and direct than that of the latter stream. The line eastward from our present camp should be continued directly to where it should cross Green river, near the mouth of Black's fork, and be continued thence eastward by the line followed by Captain Stansbury from Green river, by way of Bridger's Pass, to the

Great Plains, in 1850, as reported by him in his expedition to the Great Salt lake, and thence descend by the South fork and main Platte, or pass over to the Republican fork of the Kansas, and descend it to connect at a suitable point with eastern lines of commerce.

April 12.—It began to snow at dark last evening, and continued without intermission until late this afternoon. Several of the party were still suffering severely from snow-blindness, and many of our animals were becoming weak and exhausted for want of sufficient nourishment. I determined, therefore, to leave a portion of the party in camp on Smith's fork with the weakest animals, and to proceed with the balance to Henry's fork of Green river, a route represented to possess superior advantages to that before indicated for a railroad, to the east from Smith's fork. With Captain Morris, Mr. Egloffstein, and Mr. Snyder, and a small escort, and with our Delaware guide, I started—the snow being four inches deep as we left camp, and falling so fast that we could not see beyond a few hundred yards, but fortunately the storm was in our backs—bearing a little to the southeast to avoid the mud of the plains, which were very slippery and soft. We travelled over a succession of low hills, and crossed two or three small branches of Smith's fork, coming to Cottonwood creek at 1 o'clock, p. m., where our altitude varied but nine feet from our morning camp. We here came upon a wagon road leading from Fort Bridger to Henry's fork by a low pass in the small mountain spur dividing the waters of that stream and of Cottonwood creek. It is six miles from the creek to the summit of the pass, and the difference of level 266 feet. Entered from the north it is narrow and direct, and is formed of horizontal strata of clay, from six to fifty feet thick, often separated by thin strata of sandstone; and the clay itself in some parts is indurated to an argillaceous stone containing considerable sand. It is washed into a thousand gullies and ravines, and its slopes are barren. The spur itself is level upon its summit, and preserved from washing by a capping of stone.

Notwithstanding the storm, our guide related an incident which occurred to him a few years since in this pass, characteristic of the adventuresomeness of his own tribe, and of the war habits of his race.

He was travelling this pass at midnight, accompanied by his squaw only, both mounted upon the same horse, and the night so dark that he could neither see the outlines of the hills nor the ground at his horse's feet, when he heard a sound, (which he imitated) so slight as scarcely to be perceptible to an Indian's ear, of an arrow carried in the hand striking once only with a slight tick against a bow. Stopping, he could hear nothing, but instantly dismounted, his squaw leaning down upon the horse that she might by no possibility be seen, and placed his ear to the ground, when he heard the same sound repeated, but a few feet distant, and was therefore satisfied that, however imminent the danger, he had not yet been heard or seen, for no Indian would make such a noise at night in approaching his foe; he therefore instantly arose and took his horse by the bridle close to his mouth, to lessen the chances of his moving or whinnying, and one hundred and seventy of his deadly enemies, the Sioux, on a war party, filed past him within arm's reach, while he remained unobserved.

We encamped on Henry's fork after a ride of 23.50 miles, descending for 3.20 miles, from the summit of the pass, 122 feet to the mile. The valley of this stream is of the park-form, ten miles in diameter at our camp, with bottom lands from one to three miles in width, narrowing rapidly as it descends. The bottom is finely grassed, while the hills about it are barren or covered with artemisia; but the mountains to the south are quite covered with pine. The water of the stream flows in several channels through the meadow, which might be easily irrigated, and support a small settlement, if not too cold for cereals.

April 13.—Leaving half of our men in camp, we descended the valley, crossing several little streams, the largest of which is called Dry Timber creek, and seven miles below camp bore off to the right, and ascended a high point of the adjacent mountain to obtain an extensive view of Green river and of the surrounding country. The snow, scarcely two inches deep in the valley, soon increased to a foot and more, and our animals waded heavily through the deep

drifts and gullies. We were rewarded, however, for the labor of the ascent by the excellent view obtained.

The valley of Henry's fork continues its uniform descent to its junction with Green river, fifteen miles distant, and immediately to the south of it two other small streams enter Green river from the west, separated by a pile of rocks called the Beaver Lodge, which is also the name of the northern stream; the southern being known as Medicine Spring creek by the Indians, and Blue by the trappers, from a fine spring somewhere near its source. Fifty miles distant the Uinta mountains were seen, terminated to the east by the passage of Green river, and through a large gap in an intervening range the pine-covered sides of Brown's Hole were distinctly visible. Above the mouth of Henry's fork stand two isolated buttes of the same altitude as the low range, to the north of this stream, which we crossed yesterday, and of which they once formed a part. Green river descends from the north just to the east of these buttes. Beyond this river, to the north and east of Brown's Hole, high ranges of mountains, covered with snow, extend far to the east and to the south of the line indicated for the railroad from our camp on Smith's fork. So far as this proposed line can be seen from this point—which it can be far east of Green river—it appears very level. But the wind whistled cold and piercing about our heads, and, standing knee-deep in snow, we were soon chilled through, and, hastening our notes and observations to a close, descended in an hour and a half to Henry's fork, to a comparative summer climate—a change from 34° to 50°—the snow having entirely disappeared from the valley during our short absence.

Notwithstanding the severe snow-storm yesterday, the party suffered quite as much from blindness as during a bright sunny day, my own face becoming somewhat inflamed for the first time, and "Ring," a bulldog which accompanied us, became so much affected that he could not be induced, in camp, to open his eyes, from which tears were constantly falling. We returned at evening to our morning camp.

April 14.—We repassed the divide by which we entered the valley of Henry's fork. From Cottonwood creek, we followed a line across the artemisia plains or mesas, a little to the north of that followed in our outward journey. The light and friable soil of these plains is now saturated with water, from melting snow, and is miry and slippery. They are terminated to the west by abrupt bluffs of clay, so steep and slippery, that, in descending them, we were obliged to dismount, and let our mules slide down as they best could—ten and twenty feet at a time. They decline rapidly to the north, and, apparently, soon entirely disappear in that direction. Grass is confined to the borders of the water-courses, the intermediate spurs being occupied by fields of artemisia. We encamped at evening on Smith's fork, a short distance below our camp of the 11th instant, and on the following morning (April 15) continued our western course, recrossing Black's fork and the ridge separating it from the Muddy, on which we encamped a little above the emigrant road to Great Salt lake. Although the valley of this stream is not so broad and direct as that of Black's fork, a railroad could readily ascend it to intersect our outward line at its crossing; but, as before stated, the line then indicated would probably be preferable.

April 16.—The country over which we passed to-day is very elevated and dry, and the vegetation principally confined to artemisia. It overlooks our outward path to the south, which preserves its superior appearance even from this distance. We encamped on Bear river, about which the snow had nearly disappeared. The grass has not yet sprouted, however, for a new growth, and our animals fare badly on that which has been buried under the snow from last year, and is now soaked from its melting.

April 17.—We returned to the head of White Clay creek this morning, and descended it, encamping two miles below its Beaver branch junction, when we again returned to fields of fresh grass. High up on the sheltered faces of a few bluff rocks, cropping out on the southern bank of the creek, as we descended it, large numbers of nests of clay, in clusters of pine-apple size and form, were seen, which our Delaware guide says are built by a dark-colored bug, which

is good to eat when boiled. I could obtain no specimens of them. The guide killed a fine elk near camp.

April 18.—We attempted to-day to find a more direct route to the Kamas prairie and Timpanogos river than that by the mouth of White Clay creek and Weber river. In leaving camp, we ascended a narrow ridge, and again almost immediately descended its opposite slope, and crossed a small creek, beyond which, in ascending the succeeding hill, we entered upon a field of snow, two feet in depth, which was too soft to bear our animals, and was filled with brush and concealed fallen-timber, rendering its passage for a mile a severe labor; and several smaller fields were passed in crossing a broken country, until 11 o'clock, when we were rising a high ridge, and expected, at its summit, to find an end to our snowy labors, and to descend with comparative comfort to the prairie; but the snow had driven us off the summer trail, and, as we rose to the summit, we were greeted by the sight of another formidable ridge, everywhere presenting one immense field of snow apparently impassable, and the guide came to a stand—his last horse had failed. I however examined the country attentively, mounted the guide on a mule, and determined to go on, and in two hours, by severe labor, reached the succeeding summit; but, instead of seeing an end to our labors, and refreshing fields of grass at our feet for our exhausted stock, we saw before us only a precipitous descent of half a mile, followed by an ascent still steeper and higher than the former, which we accomplished, with increased labor, however, only to find before us an impassable field of snow, extending down the face of the mountain for several miles to Weber river. Our altitude was here 8,619 feet above the sea, and a magnificent view of the country in some degree rewarded the labor of the ascent. North, south, east, and west, the country presented only one extensive field of broken mountains. The opening made in the Wahsatch mountains by the Timpanogos cañon, with a high intervening peak or two between us and Kamas prairie, looked favorable for our passage; the high, snowy range between us and Great Salt lake, as far north as Weber cañon and Ogden Hole, was also before us, with those to the east crossed by the emigrant road. Above us, the Weber descends through an extensive mountain district, at present covered with impassable snows, and surmounted to the south by the higher and still more snowy peaks of the Uinta range.

Pine covers the steep mountain sides south of the Weber. We encamped on this summit, and sent out the guide with a party on foot to find, if possible, a practicable descent; he returned at dark with an unfavorable report, however, unless the snow should freeze during the night strong enough to bear our animals, of which there is no prospect.

April 19.—It began to rain during the latter part of last night, and the mountain sides at daylight were sending down rivulets of snow-water from every point. We were, therefore, reluctantly obliged to turn back, following, through banks of snow for two miles, the course of a small branch of White Clay creek, lying between high, steep hills and spurs of mountains. The heavy, cold rain from the southwest increased as the morning advanced, falling uninterruptedly for five or six hours, until we had gained a more open country as we approached White Clay creek. At every step, after leaving the snow, in this rapid descent, we were passing fine fields of grass, extending from the ravines to the mountain tops. We had certainly been driven higher up the mountains in our attempt to effect this passage than would have been necessary but for the snow; but it is not too much to say that there is no practicable route for a wagon-road, and much less for a railroad, by this Indian trail from White Clay creek to Kamas prairie, although it is the best in the vicinity, except that to which we returned. Soon after reaching White Clay creek, we passed our camp of the 7th instant, and again entered the valley of Weber river, in which we encamped, in the midst of luxuriant fields of fresh grass, 5.25 miles from the camp of the 7th.

In descending the mountain to-day, we passed a few out-cropping ledges of conglomerate rocks and sandstone, but soil and earth covered almost the entire surface of the mountains

and ravines. The sun shone bright and clear during the afternoon, and dried our drenched clothes. The accompanying sections of the routes explored by the Weber and Timpanogos cañones, branch at our camp of the 7th instant on White Clay creek, the former descending the Weber, and the latter ascending it.

April 20.—The wind, which had changed to northwest during the afternoon yesterday, returned to southwest last night, and the morning came in with a gentle cold rain, which increased during the day to heavy showers at short intervals. The width of the Weber valley, within the low hills, between our morning camp and Kamas prairie, varies from two or three miles to a few hundred yards; but we soon passed above the altitude of green grass, although the whole face of the country was covered with the growth of last year. It was 12 miles to Kamas prairie, which is five or six miles wide by eight and seven-tenths miles in length, and, to the eye, is as level as a sheet of water. The Weber river descends to it from the east, flows across its northern end, and thence descends to Great Salt lake, by our ascending path. A stream, ten or 12 feet wide, winds through the prairie, entering Weber river at the northwest angle of the meadow. It is seen descending from a mountain ravine on the east side of the plain, six miles distant. A mile to the south of this ravine is the divide between the Weber and Timpanogos rivers—if so slight a change of level deserves the name of divide—the latter flowing at the base of a snowy range of mountains terminating the prairie to the south. We attempted to ride directly across the prairie, but found it so miry that we were obliged to turn back and keep along the base of the hills to the west, reaching the Timpanogos where it leaves the prairie. The average grade from our camp of April 7, on White Clay creek, to our morning's camp, 5.25 miles, was 3.80 feet per mile; and 53.90 feet per mile for 12 miles thence to Kamas prairie; and across the prairie to Timpanogos river, 8.70 miles, 8.80 feet per mile—the altitude of the prairie at Weber river being 6,319 feet above the sea. Below the prairie the Timpanogos river descends in a bottom varying from 100 to 250 yards in width, covered by cotton-wood. It is enclosed on the south by mountains, and on the north by high walls of a coarse feldspathic granite, from one to two hundred feet high. The stream is twenty-five feet wide, with a rapid current. This bottom is entirely free from snow, and sufficiently wide and elevated above the river to admit of an easy construction of a railroad.

We encamped some two miles from the prairie and river, on its right bank, among the hills.

April 21.—It continued to rain during the whole of last night, and this morning snow was mixed with the falling rain; but after being two or three hours on the road, we passed below the storm, which continued about the higher mountain peaks throughout the day. We returned to the Timpanogos river at the lowest point on it visible to us from Kamas prairie last evening, its valley being here half a mile wide, and, for three miles, very miry from the great amount of rain recently fallen upon it, and covered with willows. We therefore kept along the base of the hills, and occasionally passed over considerable spurs extending into the valley. Below this the stream enters a broad open valley, several miles in diameter, called Round prairie, in which it receives small tributaries from the east and south. In this prairie the grazing is very fine; and the valleys and mountain sides along our path, throughout the day, were covered with the finest fresh grass from an inch in height at our morning camp, to eight inches at that of this evening. In the prairie the stream bends more to the west, and preserves this course, as the valley narrows to a few hundred yards in width as we approached the eastern base of the narrow Wahsatch chain. Entering the mountain, the valley becomes still more narrow, and in a short distance quite disappears, and the passage becomes a formidable cañon, in which the general course of the river is very direct; but the hills or mountain spurs, which extend down to it, slightly overlap each other, giving it a zigzag line upon a small scale, the projecting points overlapping but a few feet, and are generally not high. The southern bank is much the most abrupt, the wall becoming so nearly vertical as to be inaccessible. The rock at the base is chiefly a hard blue limestone, capped towards the summit of the mountain, with a stratum of argillaceous sandstone of great thickness. On the north side of the river, the

mountain is terminated more in stages; yet it is very abrupt, and we had some difficulty at times in following the Indian trail along its face, in its natural state. These rocky precipices, rising one above the other, soon gain an elevation of two and three thousand feet, and the highest points finally attain an altitude of 4,000 feet above the river. The dip of the stratified rocks, wherever they are exposed, is from the river, and consequently there is little danger of landslides in this gorge. The river as it enters the cañon is thirty yards wide, flowing with a strong current; but towards the foot it becomes still more rapid, breaking with considerable noise over the rocks in its bed. The pass, which is ten miles in length, varies in width from one hundred to three hundred yards; and in constructing a railroad through it it would be necessary to cross the stream several times, to avoid short curves, which could be done as easily as bridges are usually built; and considerable blasting of rocks would be requisite at various points, but amounting to no large aggregate. A little pine grows on the mountain sides quite down to the river, but it seldom exceeds 8 or 10 inches in diameter.

The descent per mile for the first 5.70 miles from Kamas prairie, is 32.90 feet, and 60.90 feet to the mile for the next 5.20 miles; for the succeeding five miles it is 44.40 feet per mile, and six feet to the mile for the succeeding 5.40 miles; and for three miles from the head of the cañon the average descent is 30.10 feet per mile; and for the succeeding eight miles, to our camp below the cañon, 39.60 feet per mile. Our altitude at this camp was 5,077 feet above the sea, and 150 feet above the river.

April 22.—We descended the river a short distance this morning, and then turned around the base of the mountain northward into the valley of Utah lake, which lay beautifully bright below us. A railroad from the Timpanogos cañon should follow the same line, gradually descending into the valley and passing through its numerous Mormon settlements to the foot of Utah lake, where it should cross the Jordan, and, if practicable, cross the Oquirrh mountain through Cedar valley to the west of Lake Utah—the appearance of this part of the mountain, seen at considerable distances both from the east and the west, rendering it worthy of examination, if at any time a railway shall be constructed west from Timpanogos river; but if this route should be impracticable, then it should descend the valley of Great Salt lake to the north end of Oquirrh mountain. The descending grades by the latter line will be 33.80 feet per mile for 14.20 miles, from the foot of the cañon to the American fork; and 3.50 feet per mile for 39.60 miles thence to our camp of the 6th of May, at the northwestern angle of the valley of the Jordan. This unobstructed valley, of 20 miles in width by 30 in length, is largely susceptible of irrigation and cultivation, and already contains many Mormon settlements, of which Great Salt Lake City is the principal.

It began to rain violently at 2 o'clock p. m., and continued until dark, soon after which I arrived at Great Salt Lake City after a ride of fifty miles. Latitude 40° 45′ 37″.

CHAPTER II.

From Great Salt Lake City to the valley of Humboldt river—May 1 *to* 23, 1854.

Receipt of orders.—Explorations performed in anticipation of the receipt of these orders, and extract therefrom.—Leaving Salt Lake City.—Valley of the Jordan.—Grass and springs.—Railroad line by the south end of Great Salt Lake.—Snow-storm.—Scenery in entering Tuilla valley.—Mormon settlements.—Old shore-line.—Formidable pass —Goshoot Indians.—Indian guides —Salt and warm springs —Character of rocks.—Water driven over marshes of the lake.—Birds.—Springs in conglomerate rocks.—Fish.—Spring or Lone Rock valley.—Frémont's route of 1845, and Stansbury's of 1849 —Railroad route.—Gophers and grass-seed as Indian food.—Passage of Cedar mountains.—Scarcity of water.—Pass not suitable for a railway.—The Desert to Granite mountains and Fish springs.—Storms.—Mirage.—Railroad route to the south and west of Pilot Peak.—Miserable condition of Goshoot Indians.—Examination of first range of Goshoot mountains.—Rock; grass; timber.—Fish creek.—Railroad route.—Shoshonee Indians.—Striking contrast between the Shoshonees and Diggers, (Goshoots).—Passage of successive ranges of Goshoot mountains.—Vegetation and rocks.—Gate of Narrow Pass.—Rain; hail; springs.—Wretched condition of Indians.—Frost.—Goshoot lake.—Digger wick-ey-up and its occupants.—Digger language.—Topographical sketches of railroad line *via* Pilot Peak.—Franklin River valley; its lakes, rivers, and vegetation.—Old lake-shore.—Hastings's road.—Route for packing-parties.—Pilot Peak railroad line.—Remarkable formation of the basin.—Humboldt Mountain railroad pass.—Country as seen to the west of this pass.—Snow in the pass.—Rocks in the pass.—Valley of the Humboldt, by Colonel Frémont.

May 1.—I received on the first of May, at Great Salt Lake City, your orders of the 21st of February preceding, directing me to make the explorations and surveys of the passes eastward from the Great Basin embraced in the preceding part of this report—these surveys having been made in anticipation of the receipt of the instructions referred to, or, in case of their non-arrival, to facilitate the completion of the explorations already ordered—and then to retrace my steps and survey the route which I had proposed, "passing to the south of Great Salt lake in the direction of the 'Sink' of Humboldt or Mary's river, thence towards Mud lake and across to the tributaries of Feather river, and thence by the most practicable route to the valley of the Sacramento river."

May 5.—Leaving Great Salt Lake City, we encamped on the west side of the Jordan, which is now flowing with a muddy, turbid current, considerably swelled by melting snow.

May 6.—The wind blew heavily during the latter part of last night, and a slight fall of rain renewed with vigorous freshness our previous realizations of camp life; and slight showers rapidly succeeded each other, crossing the valley of the Jordan from southwest to northeast during the day. At this season this valley is supplied with a growth of green grass which occasionally forms a sward, but is generally thinly scattered over the surface among the varieties of artemisia known as sage and greasewood. In crossing the level valley from the Jordan, the road is now very good; but during the rainy seasons there are a few miry alkaline beds, which are for the most part, however, easily avoided by making a short circuit to the right or left. We ascended slightly the base of the Oquirrh mountain, and encamped in abundant fields of grass. Large springs burst out along the northern base of this mountain near the Great Salt lake, but are generally more or less brackish; yet the water is used by the few Mormon families settled about them. Day's march, 12.98 miles; altitude, 306 feet above Great Salt Lake City. In constructing a railroad, however, this altitude is entirely unnecessary, as the road can be carried nearly on a level with the water of the lake, without a material change of grade while in its vicinity. It is at this point that a road descending the Timpanogos river, and passing by the north end of Lake Utah, should intersect one descending by the Weber, and passing to the south of Great Salt lake, unless it shall be found practicable by the former line to pass the Oquirrh mountain through Cedar valley.

May 7.—A disagreeable night was followed by a high wind and a heavy snow-storm from the northwest, which drove in our faces for two hours while we were passing around the north end of Oquirrh mountain to Tuilla valley. The scenery in turning this point, in the storm, where we came directly upon the shore of the lake, with several islands rising abruptly from its waters, with high mountain shores and extensive mountain ranges in every direction, was very beautiful, and caused regret at the taste displayed in the selection of the site for the neighboring city, from which this beautiful sheet of water is seldom visible, and never appears picturesque. But as it is a city of farms, necessity doubtless dictated its own terms.

The Mormons have several small settlements in Tuilla valley, which is ten or twelve miles in width, and extends south from the lake for some twenty miles, where it is crossed by a cross-range with low depressions at either end; the eastern leading into Cedar valley, and the western along the eastern base of the high range forming the western limit of this valley. The eastern side of this valley is finely grassed, but in crossing it the road lies through a continuous artemisia field, more or less interspersed with grass. For five or six miles in crossing, our road lay along an old shore-line of the lake, elevated some twenty feet above the general level of the valley, into which it gently subsides near a fine spring of water, flowing off in a bold little stream towards the lake. We encamped, after a march of 20.59 miles, on Willow creek, three and a half miles above or south of the most western Mormon settlement upon this line, and directly at the foot of what had been favorably represented to us as a pass by which to cross the mountain. But its appearance as we approached it was too formidable to require further examination; and the Indians who came to our camp informed us, that it is with the greatest difficulty that a horse when led can ascend by this trail when free from snow—which it is not now—and that with a rider it is impassable. Altitude of camp, 4,487 feet above the sea, and 170 feet less than at our morning camp.

Sho-ish, a Utah chief, had sent a runner to his neighboring band, the Goshoots, upon whose territory we were just entering, to say that I was his friend and made very fine presents to his Indian brethren, who accordingly presented themselves at our camp, and were delighted with the trinkets which they received; and I employed two or three of them to accompany me across their own deserts and mountains, no reward being large enough to tempt them to introduce us to their western neighbors, of whom they stand in great fear. Snow-squalls continued during the day, whitening the valleys to the water-level of the lake, and ice formed during the night.

May 8.—After some slight examinations of the mountains to the south, we turned down Willow creek, and passed north along the base of the mountain towards Great Salt lake, passing several saltish springs and one warm spring, and encamped opposite Stansbury's island, 13.70 miles from our morning camp, and 4,238 feet above the sea. The rocks of the Oquirrh mountain, near Black Rock, and those near our present camp, are conglomerate and sandstone, with others changed (metamorphic) by igneous action, standing in nearly vertical planes. Ducks, gulls, and snipe of a large species, were killed in considerable numbers about our camp, and mosquitoes and gnats were very troublesome. The driving of the water, by the wind, upon the nearly level marshes which border Great Salt lake, presents a marked resemblance to a flowing tide, which has its counterpart in the ebb at the falling wind.

May 9.—Before passing around the north point of the mountain, three miles from camp, into Spring or Lone Rock valley, we passed several salt springs, one of which was blood-warm, sending out a fine stream of water beautifully clear at its source, at which gas was constantly bubbling out; and, as we entered the valley, these springs became more numerous—the finest of which sent out a volume of water two feet in width by three inches in depth. This spring issues through a mass of conglomerate rock, and is inhabited by a multitude of small fish two or three inches in length, which retreated into the spring under the rocks at my approach. Several other springs, as we passed on, were far less salt, but our horses drank of them

reluctantly. Our path led all day through fine fields of grass, which sometimes occupied the surface unopposed by more hardy plants, but at others was thickly interspersed with artemisia, of the greasewood and rabbit-bush varieties. The large central portion of this valley towards the lake, is an alkaline plain, too soft and miry to be conveniently crossed. It is terminated to the west by Cedar mountains, a range parallel with, but not so elevated as that to the east of the valley, which is twenty miles wide. We encamped, after a march of 21.45 miles, on a fine litle creek a foot in width, descending clear and cold from the highest snow-peaks of the range to the east. It would serve to irrigate a few farms before reaching the alkaline bed just mentioned, in which it sinks. High up the mountain peaks above our camp a few dark masses of pine are seen, and cedar extends nearly down to the valley. Our camp is a short distance south of the line by which Colonel Frémont crossed this valley in 1845, and Captain Stansbury in 1849, and by which it should be crossed by a railway to Cedar mountain, which should be crossed by the route followed by Frémont, where the altitude of its summit is given on the map "drawn by Mr. Charles Preuss from the surveys of Colonel Frémont and other authorities, under an order of the Senate, in 1848," at 5,009 feet above the sea, or about 800 feet above Great Salt lake, or by lower depressions still further to the north, if it should be found desirable. In its course west from this mountain, it should be carried as far as practicable to the south, without unduly increasing its length, to avoid the miry plains nearer the lake—these plains becoming firm in proportion to their distance from it—passing by one of the open spaces to the south of Pilot Peak, by which the succeeding chain of mountains to the west is terminated to the south, and thence be continued by the north end of the succeeding western range towards the head of Humboldt river. For a faithful and lucid description of this part of the line, I beg to refer you to Captain Stansbury's report of his expedition to the Great Salt lake, chapter vi, pages 111 to 116; and for its delineations, to the map before referred to, made by Mr. Preuss. The passes and the country delineated by him in that vicinity were observed with much attention by us from the line which we explored a little to the south of it, our observations confirming the general character of the country as represented on this map, but materially adding to the positive knowledge of it, as will be seen by reference to the accompanying map. We crossed this desert on the 12th and 13th instant, under which dates its description will be found.

May 10.—By the advice of our Indian guides, we crossed Lone Rock valley by a very direct course to the pass in Cedar mountains, which they represent as leading to the best route by which the desert west of it can be crossed—the pass itself, in their estimation, being superior. The rise from the centre of the valley to the foot of the pass is very gradual, and its whole surface is covered with small varieties of artemisia, neither grass nor water being found near the road. The valley southward trends considerably to the east, and is uninterrupted as far as our vision could reach, although a low mountain extends into it for a considerable distance from the west, but eventually terminates in the plain. A small growth of cedar is scattered uniformly over the mountain in the vicinity of the pass, in which we encamped at a small spring of very bitter water, after a march of 15.18 miles, grass being abundant on the mountain sides. We met three Goshoot Indians during the morning, who accompanied us to camp. They were armed with flint-lock rifles and powerful elastic bows, made from the horns of the mountain sheep. Our most intelligent guide, Shippah, pointed out to me a small variety of ground-rat or gopher, and a black beetle-like cricket, which furnish a very large proportion of the food of his people. The grass also, on the seed of which they feed, he thinks of interest, and points out every tuft which we pass.

May 11.—The ascent became more steep as we approached the summit of the pass; the ravine narrow, and covered with a thick growth of stunted cedar, through which we were obliged to cut a road; and the descent still more abrupt and narrow, forced us to cut a road along its sides for a hundred yards—a considerable labor, as the ground was hard and rocky. Fortunately, just below the summit, we came to a small rivulet of running water, which leaks

from the indurated shale and dark-blue limestone, overlaid by igneous rocks, of which the mountain is composed, and is much purer than that at our morning camp, which did not afford a supply at all adequate to our wants. The Indians say, however, that when the sun is hot, (mid-summer,) there is no water in this pass. It is not suitable for a railway. Like many of the mountain ranges in the Basin, this terminates in the plain to the south, and can be passed around by a long circuit. It was late when we extricated ourselves from this pass and encamped, having accomplished the short march of only 3.68 miles. The day throughout was dark and cloudy, and at night camp-fires were necessary to comfort, fuel being abundantly supplied by sage.

May 12.—We mounted our Indian guides on mules to-day, and furnished them with scarlet cloth for blankets, greatly to their delight—a merrier set of thieves seldom being seen. The morning was dark and cloudy, and a slight rain which fell during last night had moistened the light friable soil of the hills, making our early ride cool and pleasant. Leaving the base of the mountain, (2.43 miles from camp,) we crossed a field of heavy sand, and a few spaces of hard, barren white clay, succeeded by another field of sand, and then entered upon a soft, moist bed of clay or stiff mud, more or less miry at short intervals for nine miles, in which our riding-animals sank to the top of their hoofs, and occasionally to their fetlocks, and over which our loaded wagons dragged heavily. Eleven miles from the base of the mountain, however, brought us to an extensive field of small artemisia, extending far to the right and left, and sweeping quite up to the base of Granite mountain, which we were approaching at its northern termination. In this field the soil was light but dry, and the travelling fine; and we encamped at the point just spoken of, where we found a fine permanent spring of pure cold water issuing in abundance from the granite rocks in the bed of the ravine three-fourths of a mile above our path; but we were not so fortunate in regard to grass, only a few scattered bunches being found on this part of the mountain, which is a large isolated mass of granitic rocks, rising from the desert in which it stands, like an island from the ocean, to an elevation of 2,000 feet. Its general appearance is that of whitish naked rock, with a few small cedar-bushes in its narrow ravines. It disintegrates considerably, and forms the surrounding soil, which is filled with quartz and mica. Day's march, 19.76 miles; altitude of camp, (considerably above the plain) 4,666 feet above the sea.

May 13.—We resumed our journey at 5 o'clock a. m., directly across the desert, (which is that crossed by Stansbury, further to the north, where it is 70 miles wide, to which I have before referred,) south 45° west, (magnetic,) to the nearest point of the Goshoot mountains, which derive their name from the Indian band inhabiting them, although the name might better have been applied to the desert, which is characteristic of their utter wretchedness. Five miles from Granite mountain, we left the dry soil on which we terminated our march last evening, and passing over a narrow ridge of sand, entered upon a desert of stiff mud, as level as a sheet of water, which we found great difficulty in crossing with our wagons for 17.66 miles. For this entire distance there is not a sign of green vegetation, and only here and there a dry stalk of artemisia, where it has been transported by the wind. The lightest sheet of effloresced salt covered the moist earth at intervals, and the track of a single antelope or wolf could be seen crossing the desert for miles, by the line of dark mud thrown up by its feet, so level, white and soft was the plain; and the whole scene was as barren, desolate, and dreary as can be imagined. Fortunately the sun was partially obscured during most of the day; but even with the obscurity its reflection was very painful to the eyes, which were materially relieved, however, by one or two light passing showers, which dissolved the salt upon the plain, but greatly enhanced the fatigue and labor of crossing it. These storms, however, which had been hanging about the high peaks of the mountains all day, accompanied by thunder, increased in number and violence in the plain as we approached camp, and were accompanied by heavy squalls of wind from the southwest, and we were brought to a stand by a hail-storm, to which our animals turned their backs and obstinately refused to move until it had passed. Every

object, when it was not storming, was distorted by mirage, rendering it impossible to form correct estimates of objects seen at a little distance—trees dwindling to mere twigs, and extensive lakes to glistening surfaces of mud, as they were approached. Very irregular detached mountain masses lay a few miles to the south, and a single one to the north, conforming in their course to no general theory of parallel lines of crests. The passage to the south of Pilot Peak, and another south of it, looked open and level, and it is by one of these that a railroad should pass west from this desert; the plain of which sweeps entirely around Goshoot mountains, preserving the same level, or nearly so, of our path and of the Great Salt Lake shore, where a road is already graded, or nearly so, but upon which it will be expensive, however, to construct a firm foundation for the road; for which extensive piling will be necessary in crossing all the miry beds. Approaching the Goshoot mountains, we came to a more firm and dry soil, covered with artemisia, for 2.34 miles to the foot of the outlying hills, where we found fine large springs of fresh water, sending out considerable streams to the plain. They were surrounded by large meadows of excellent grass. These springs are filled with small fish, and the Indians, therefore, give them the name of Pangwich or Fish springs. In anticipation of meeting their friends here, our guides dismounted before leaving the desert and prepared their toilet, for which they removed the dark surface-mud of the desert for two or three inches in depth, when they came to a white-clay mud stratum, with which they painted (bedaubed) themselves, in stripes, to hideous ugliness, remounted their mules, and appeared before their friends in holyday costume. We were soon visited by a number of the expected guests, extremely filthy and very naked, and emaciated by starvation during the long winter, during which their supply of rats and bugs fail, and they are reduced to the greatest extreme of want, if their appearance truly indicates it; and they are doubtless among the lowest of the human race in intelligence and humanity. We fed them and made them happy with small presents. There is a little scattered salt grass without the oasis spoken of; but it only extends a short distance, and is succeeded in the hills by artemisia, and in the desert by utter, desolate barrenness.

The teams arrived at camp between 6 o'clock and dark, very much exhausted by a march of 25.32 miles, in thirteen hours of incessant labor after a night of fasting. This desert, by the line by which we have crossed it, is forty miles wide, but less than thirty miles of it particularly deserves the description given of it where it is 70 miles in width further to the north, and the fine water in Granite mountain greatly relieves the hardship of crossing it by the southern line. Altitude of camp, 4,659 feet.

May 14.—It rained heavily during last night, and showers continued to fall in the mountains throughout the day, during which Captain Morris and Mr. Egloffstein made a reconnoissance of the mountains, and found them very practical for the passage of wagons. Camp was not moved.

May 15.—A heavy fall of rain at camp during last night, covered the mountains well down towards the desert with snow. Accompanied by Lieutenant Baker, Messrs. Egloffstein and Snyder, and a few men, I ascended to the summit of the mountain, and proceeded northeast along it, seeking for the best pass, and to determine with more certainty the practicability of turning its northern base. It is covered with fine grass and a low growth of cedar. The rocks were metamorphic, shale, and limestone. At 3 o'clock p. m. we descended to a fine creek six feet in width, descending from high snow-peaks to the south, and running along the western base of the first range of the Goshoot mountains, and breaking through it by a broad passage into the desert, where it disappears. The accompanying profile of the country explored crosses the desert from Granite mountain to the mouth of this creek, which it ascends to our evening camp. But it is still to the north of this line that the railroad should be carried by the line already indicated, and to which I should have immediately proceeded, had I not been led to suppose, by the Senate map of 1848, that the material from which it was constructed was in the possession of the government, and that the re-examination of the country

was therefore entirely unnecessary. But, as I have already stated, our observation of that line was quite sufficient to determine its entire practicability and excellence as a railroad line. We now turned south, following Fish Creek valley, which is from 250 to 300 yards wide where we entered it, but soon opens to a much greater width, and sweeps off to the south and southwest. Ten miles brought us to camp, the main body of the party having crossed the mountains, under Captain Morris' direction, by a superior wagon-road measuring 18.63 miles. The valley is here several miles wide, and the stream lined with grass, which is not all, however, of a superior quality. Many of the small settlements of Utah are not so well supplied with the requisites for successful cultivation as those found on this stream, on which we found a band of twenty Shoshonee Indians encamped, besides women and children. They are mounted, and contrast strikingly with their Goshoot neighbors (Diggers) in the plump condition of their persons, although they complain of hunger; and in clothing, blankets and buffalo-robes being common among them. Our Indian guides left us here, as we were approaching the western line of their territory, and we endeavored, unsuccessfully, to obtain one from the Shoshonees to accompany us—their perfect knowledge of the country being of great service in designating the points at which water and grass can be found.

May 16.—Leaving camp, we took a nearly west course by the shortest route we could discover, leading to a favorable passage of the low mountains in that direction. The country was at first gently rolling, but soon became more broken and hilly, and covered with an unusual growth of cedar—artemisia covering the whole face of the country, and the soil light and dusty. The rocks of the lower hills were an indurated clay, and a sandstone, easily crumbled; but the higher hills were metamorphic, surmounted by granite. I rode to the summit of several high peaks to the north of our path, to obtain a better view of the country, and, if possible, to discover more favorable passes in this range, but without success. We therefore descended to the west to a valley but three or four miles in width—which extends northwest to the proposed railroad line, as we subsequently ascertained, and southeast to the head of Fish Creek valley, by which this mountain range can, therefore, be turned to the south, fifteen miles above our morning camp—and crossed to a pass marked by a high peak, at the southern base of which it ascends. The opening or gate to this pass, towards the valley, does not exceed 50 feet in width, the hills of metaphoric rocks being 200 feet high. The dry bed of the pass furnishes a fine road. It rained almost constantly on the mountains during the day, and a hail-storm and one or two showers swept over our path. We encamped a mile above the foot of the pass, and an equal distance below a small spring of fresh water, to which we did not proceed, as the fine grass of the mountain was saturated with rain, and we had provided ourselves with a supply in the morning, not knowing that it could be found at camp. Just before encamping, two or three Goshoots, who had declined to accompany us in the morning, came up with us, and others arrived during the night.

May 17.—We followed up the ravine, in which we had encamped, for three miles, to where a more broad and open passage to the north extends into the valley we crossed just below that camp, and, as we entered it, changed our course more to the south, and in three miles reached the divide, from which I rode two miles to the west to the summit of a high ridge, from which I obtained an extensive view of the valley to the west and of a large mountain-range beyond, extending considerably to the north and south, upon which there were still large fields of snow, and lying directly in the line I wished to explore. The intermediate valley was destitute of grass, and the distance too great, with an unfavorable light, to allow me to see any evidences of water on its western border. I returned, therefore, to the pass, and encamped a mile and a half to the west of its summit, at a fine spring, which sends out a fine stream watering a small field of grass, and again disappearing as suddenly as it rose. I made presents to the miserable, emaciated Indians who visited our last and present camps, and they were made happy not alone with cloths and knives, but pails-full of soup, on which I feed all who call on us. The morning was pleasant, turning cool towards noon, with light showers of rain in the evening. Near

sundown, I again ascended the high western ridge to examine the country ahead with a more favorable light, by which I discovered a narrow lake, to which I gave the name of Goshoot, extending along the base of the succeeding mountain-range for several miles, and indications, by the vegetation, of fine springs at the foot of the same mountain.

May 18.—Last night was cold, freezing the surface of the ground to the depth of a quarter of an inch. Altitude, 6,550 feet. Leaving camp at sunrise, we continued down the dry bed of the creek for a short distance, but leaving it as we entered the valley, in which our course changed more to the north, for the purpose of passing around the north end of the succeeding mountain. The road was dry and hard, and the artemisia, which covered the whole face of the country, small. The water of Goshoot lake is shallow and bitter, and its banks miry. Crossing below its foot, which sometimes overflows, and sends out a small stream to the north, we encamped among numerous fine springs of fresh water, around which the fresh grass is just springing up, and the willows are just beginning to show their leaves. The day has been the finest we have enjoyed, and as yet (3 o'clock p. m.) we have seen no rain falling in the mountains. Day's march, 18.40 miles.

May 19.—We continued our northwest course this morning around the mountain, but, to avoid a long circuit in the plain, passed over the foot-hills of the range through a large growth of the cedar of the country. The range itself is terminated by a high round butte just north of the line of our trail. The valley of our last camp was seen to extend well to the north, and to connect to the east by other plains with the valley above Fish creek, just below our camp of the 16th, which would give an important line for a railroad from Great Salt lake, by a very uniform grade, but by a very circuitous route, were not the line by Pilot Peak, which was in sight, and with which this valley also connects, more direct, with equally favorable grades. To the north of the open passage, beyond the terminating butte above described, there is a remarkable peak, very broad at its base and sloping gradually up to its summit, upon which snow is still seen. This peak apparently terminates a short, isolated north and south range, of which it is the conspicuous feature, and a conspicuous land-mark. To the west of this peak we entered upon an extensive plain extending uninterruptedly so far to the north, that only the highest peaks of very distant mountains were visible above it. It also extends far to the south, but is much more broken by mountains. Turning a little south, we encamped, still on the mountain base, at fine springs, which send out small streams to the plain, watering small meadows of grass before they disappear in the absorbing soil. Day's march, 16.11 miles. As we approached camp we discovered near the springs the smoke of a Digger wick-ey-up, or lodge—that is, a smoke curling upwards from the sunny side of a cedar bush. Its inmates, or more properly occupants, were an old man and a young woman, the lowest beings in the scale of humanity I have any desire to see. They were greatly frightened when they discovered us, and the man escaped to the mountains; but the woman did not see us until too late to escape; and as she experienced no incivility, her companion afterwards returned, informing us, as he best could, that he fled taking us for Shoshonees. But he was still greatly in fear, and trembled from head to foot, and, with his companion, returned to the hills as often as curiosity or hunger induced them to come forth. They were filthy beyond description, and as ugly in features as in dirt. They had no shelter, no blankets—nothing but a deer-skin or two, a few ground-rats, a little grass-seed in grass baskets, food for themselves, and a variety of artemisia-seed, which the squaw ground between stones for food for two of the most emaciated and mean-looking dogs I ever saw. We could not discover the use they put these animals to in this condition, for they could barely stand, and the woman was constantly beating them with clubs to keep them from lapping the stones upon which their food was ground; but they were very anxious to obtain the fat dogs in our train for food. I made them presents of knives and calico, which astonished them not less than our arrival, by which they were made as happy as they were miserable an hour before. We fed them also, but they were, although half-starved, afraid to eat until they saw us partake of the same dish, so little are they accus-

tomed to kindness from strangers. Their dialect was a gibberish which none of us could in the least understand, except when they introduced a word or two of some adjacent tribe. The language of the Diggers, in general, is a corruption and intermingling of a few words from those of each of the surrounding tribes, from whom, in part, they come themselves, it is said, being the Botany Bay fellows of all the Indian tribes in the great mountain world around them. They live a family or two in a mountain, and know nothing beyond the rat-holes of their own hills, being afraid even of their next range neighbors.

May 20.—I despatched my assistant, Mr. Egloffstein, with a party this morning to the northeast, and to the east of the high peaks described yesterday, to make topographical sketches of the route, and determine with accuracy the continuousness and practicability of the railroad line by Pilot Peak, to which we were about to return, while with the main party I crossed the plain west of our morning camp, and passing between low hills on the right, which are easily passed around by the north by the line for the railroad, and a considerable mountain to the left, entered the large valley, twenty miles in width in its broadest part, by sixty in length, lying at the eastern base of Humboldt mountains. It connects directly with that seen to extend so far to the north yesterday—indeed it is here the main part of that valley, which could be followed by a railroad, passing by the north end of Great Salt lake, and crossing the Humboldt mountains by this line. It is the most fertile valley known to exist in the centre ot the Basin. Numerous streams descend into it from the elevated range of the Humboldt mountains, all the crest of which for a thousand feet below its summit is still buried in snow. To the largest of these streams I gave the name of Franklin river. It rises, by the union of several small streams, in the pass by which it is proposed to cross the mountain with the railroad, descends to the east to the base of the mountain, and thence flows south for many miles, forming the most considerable lake in the valley, of which there are several, but none of great extent. The lakes are surrounded, and all the streams are lined, with extensive meadows of coarse, tall, luxuriant grass; and the water, so far as we could ascertain, at least at this season of the year, is fresh, but near the lakes has a strong taste of decaying vegetation. The richest of the lands are, unfortunately, too low and wet for cultivation to their full extent; otherwise it would furnish lands for a respectable settlement.

We passed directly along the shore of one of the numerous ponds soon after entering the plain. It is shallow and its water colored by the clay of the soil, and not more than a mile in length. The day was bright and clear, and we rode for several miles in a due west course from this pond, although this course would bring us directly to the base of the mountains, where there is no possibility of crossing them; but the width of the plain is such—as we travel without any knowledge of the country in advance, not having been able to find a single person who had any knowledge of it by the line I wished to follow—that it is necessary to be sure of finding water and grass for our animals at night, which we could not fail to do at the foot of the snowy range we were approaching, although it increased the distance to travel beyond what it would otherwise have been. But in the middle of the plain we came upon Franklin river, the channel of which is thirty feet wide at present, and it has everywhere overflowed its banks; but in mid-summer it is doubtless a small stream. Turning north, towards the pass in the mountains, we encamped after a march of 21.52 miles, on the banks of the river, which are destitute of timber, but sage furnishes abundant fuel. I observed in the plain a curved line crossing it in a general northeast and southwest direction, and elevated perhaps 20 feet above its general level, evidently the shore of a lake which has existed here within a modern geological period.

May 21.—To avoid ponds and miry places, we were obliged to change our course more to the north, and in six miles crossed the wagon-road opened by Hudspeth and Hastings in 1846, in conducting a party of emigrants to California. It has been frequently followed since, but cattle are seldom in a suitable condition to cross the desert from Great Salt lake to Pilot Peak the same season that they leave Missouri. But it can be safely crossed by the line which

we followed; but on arriving in this valley travellers should bear to the south, and intersect the line one day's journey to the north of the pass to which it leads in the Humboldt mountains. Packing parties can easily cross by the northern pass, however, to the valley of Humboldt river. Antelope, sage-cocks, and ducks were quite numerous in the plain and on the ponds.

Mr. Egloffstein and party rejoined us at noon. His observations and topographical sketches conclusively establish the practicability of the railroad line crossing from Cedar mountain to the south of Pilot Peak, and thence to our present camp—and its consequent superiority to all others in this vicinity. The general grades upon it will be readily determined by a reference to the level of our camps of the twelfth and thirteenth of May, and those of yesterday and to-day. The same references will also exhibit a singular feature in the formation of what is called the Great Basin, analogous to that observed in approaching the Rocky mountains from the east, where the gradual and uniformly increasing ascent from the Mississippi or Missouri rivers forms an immense trunk of table-land upon which these mountains are elevated. The altitudes referred to in the Desert are 4,666 and 4,659 feet, respectively, above the sea; and of our last and present camps, on quite as extensive a plain, north and south, as the former, 6,004 and 6,061 feet above the sea. And upon this elevated plateau, as in the case of the Rocky mountains, the most extensive and remarkable range of mountains we have seen in the Basin, the Humboldt, is elevated, its altitude being at least nine or ten thousand feet above the sea; and from the western base, as will be seen hereafter, a corresponding subsidence of plains takes place, extending quite to the foot of the Sierra Nevada, where we again return to nearly the altitude of the Great Salt lake. Latitude of camp, 40° 41′ 50″.

May 22.—To avoid the miry banks of numerous small creeks in the plain, we continued our course of yesterday until reaching the foot-hills of a mountain spur extending from the Humboldt mountains, from just north of the pass we were approaching, several miles into the plain, where it terminates, when we wound gently along its base, and crossed the main branch of Franklin river, (which descends from a high peak to the north of the pass,) a few yards above the plain. Though but twelve feet wide and three deep, we were obliged to bridge this stream on account of the miry character of the soil when moist, even on the mountain sides. From this creek, descending slightly, we passed over spurs of hills descending from the pass, and in 2.05 miles came upon a small rill descending from the lowest point in its summit, which was but 0.84 mile distant, 1.15 miles below which we encamped in a side ravine, finding it impracticable to descend with our wagons, on account of the miry character of the soil and of a rocky ravine commencing 1.33 miles below camp, to the valley of Humboldt river, which lies directly west of this pass. Numerous small creeks descending from various parts of the pass unite, forming a stream five feet in depth, at present, above the head of the ravine, through which it descends with a rapid current to the valley below. Its banks in the ravine are lined with willows and a small growth of cotton-wood, and large fallen rocks obstruct its easy passage, did not the soft soil forbid it. The narrow part of the ravine is three miles in length, and its rocky sides very abrupt; and some parts, particularly near its head, rise vertically to the height of 40 and 60 feet. On the north side, immediately above these rocky walls, the mountain spurs are rolling, or intersected by ravines, and rise rapidly to a much greater height than they attain directly above the summit of the pass. They are easily ridden over, however, in any direction near the stream. On the south side these hills are more abrupt, both towards the stream and the east, and are more rocky and broken, the narrow ravines partaking slightly of the character of cañones. Below this the ravine opens and is easily accessible on horseback, although the mountains are still high above it for three miles, whence they subside gradually into the Humboldt valley on the south side of the stream; but on the north side, are terminated quite abruptly by a remarkable round bald butte, standing directly in front of the pass in looking eastward from the Humboldt river. From the summit of this butte the country to the west is seen to great advantage. The Humboldt valley is broad and open for 30 miles between its main branches, which are seen descending from the north and south of this position; beyond which

the mountain chains, which rapidly succeed each other, apparently rising from a common plain, overlap, and it is impossible to trace the course of the river without reference to maps. A few streams are seen descending towards it from the mountains in the immediate vicinity, but few of them, however, reach it, their waters being absorbed by the light soil of its valley. The whole landscape, except just above us, presents a sombre and even barren aspect, sage being the prevailing plant.

The main mountain depression of this pass exceeds two miles in width to the east, but at the head of the ravine, to the west, it does not exceed a half mile in its narrowest part, including the ravine which is only 100 or 150 feet wide. Snow covers the high peaks above it, and a few drifts extend in the ravines down to the level of its summit. The rocks are granite, quartz in masses, blue limestone, and slate, altered by igneous action. In approaching the pass from the east, advantage can be taken of the mountain spur which extends into the plain from its northern edge to the right of our path, to enter it and pass its summit by a longer and easier grade even than that given in the accompanying profile, which indicates the natural grade by which we ascended it; and in descending to the west, its width and the character of the mountain sides are such that some advantage can be taken of them to effect the descent by a line following the hills on the north side of the pass, but this advantage will be confined chiefly to that portion below the rocky ravine.

The ascending grades from our morning camp, as indicated by our barometers, are, for 7.65 miles, to the crossing of Franklin river, 58.10 feet per mile, and thence to the summit of the pass, 2.89 miles, 25.10 feet per mile, the altitude of the summit being 6,579 feet above the sea; and the descending grade to the west, for the first 0.80 of a mile, 78.30 to the mile; and thence to the base of the bald butte, 8.36 miles, 96.70 feet to the mile. Below this point we enter the valley of the Humboldt river between its north and south forks, their junction being, by the course of the creek descending from this pass and the north branch of the river, thirty-five miles distant, with an average descent of 28.50 feet per mile.*

The valley of the Humboldt river having been explored by Colonel Frémont, and so favorably represented for the line of a railroad, no further examination of it was deemed necessary; and being obliged to proceed sixty miles south to cross the Humboldt mountains with our wagons, I determined to proceed west from that pass across the Basin by a route not before explored, returning to the valley of the Humboldt near the point at which it is proposed for the railroad to leave it in its western course. The 23d of May having been spent in examining the pass described, we resumed our journey on the following morning.

*The Humboldt river "rises in two streams in mountains west of the Great Salt lake, which unite, after some fifty miles, and bears westwardly along the northern side of the basin. * * * The mountains in which it rises are round and handsome in their outline, capped with snow the greater part of the year, well clothed with grass and wood, and abundant in water. The stream is a narrow line, without affluents, losing by absorption and evaporation as it goes, and terminating in a marshy lake, with low shores, fringed with bulrushes, and whitened with saline incrustations. It has a moderate current, is from two to six feet deep in the dry season, and probably not fordable anywhere below the junction of the forks during the time of melting snows, when both lake and river are considerably enlarged. The country through which it passes (except its immediate valley) is a dry sandy plain, without grass, wood, or arable soil; from about 4,700 feet (at the forks) to 4,200 feet (at the lake) above the level of the sea, winding among broken ranges of mountains, and varying from a few miles to twenty in width. Its own immediate valley is a rich alluvion, beautifully covered with blue-grass, herd-grass, clover, and other nutritious grasses, and its course is marked through the plain by a line of willow, * * * serving for fuel.

"This river possesses qualities which, in the progress of events, may give it both value and fame. It lies on the line of travel to California and Oregon, and is the best route now known through the Great Basin, and the one travelled by emigrants. Its direction, mostly east and west, is the right course for that travel. It furnishes a level, unobstructed way for nearly three hundred miles, and a continuous supply of the indispensable articles of wood, water, and grass."—*Geographical Memoir addressed to the Senate of the United States in* 1848, *by Colonel Frémont—June*, 1848.

CHAPTER III.

From the valley of Franklin river, east base of the Humboldt mountains, to the crossing of the Humboldt river—May 24 *to June* 9, 1854.

Journey along the eastern base of the Humboldt mountains.—Forty hot springs.—Mountain chiefly granite.—Eclipse of the sun.—Lakes.—Shore-lines.—Digger Indians.—Fevers.—Numerous Springs.—Outlet of subterranean river.—Passage of the Humboldt mountains to the southern branch of the Humboldt river.—Interior or secondary basin. Digger methods of catching gophers and marmots.—Indian singing, lodges, and wardrobes.—Quartz mountain.—Agate Pass.—Rheumatic fevers.—Snow-storm.—Difficult mountain passage.—Lake and miry plain.—Edible roots.—Return to proposed railroad line.—Description of the valley of the Humboldt.—Character of the vegetation of a large portion of the country between the Rocky mountains and the Sierra Nevada.—Humboldt river.—Bad character of its water and grass.—Cause of the loss of stock; how avoided.

May 24.—We travelled south along the eastern base of the Humboldt mountains, crossing numerous small creeks, and at our camp a mountain torrent, which we were obliged to bridge, although it did not exceed twelve feet in width by two in depth, but it poured by with great fury; yet we were but a few hundred feet above the plain, which we were obliged to avoid on account of the miry banks of its numerous creeks. The base of the mountain is finely covered with grass, but we occasionally passed fields of sage and thorny bushes, the latter covered with myriads of nesting caterpillars. Before leaving camp this morning, a few miserable Indians came in, but they were very wild and timid; and we met a naked, stalwart fellow during the day, whom I adorned with rings.

In the plain at the foot of the hills near our camp this evening there are some forty hot springs. Their orifices are in granite—the water boiling up as from a well into funnel-shaped basins, and a small pond is formed by their united waters, with vertical granite walls even with the surface of the plain. There is a slight odor of sulphuretted hydrogen about them, but the water, when cooled, tastes pure and fresh, and is limpid. They are more or less intermittent in their action, and the temperatures of the different springs vary from 120° to 170°, and the total amount of water which they discharge is small. The mountain above us and along our path to-day is almost entirely granitic—sometimes very fine, at others feldspathic and crumbling, or micaceous and disintegrating. The morning was very beautiful and pleasantly cool, and mid-day warm; but we were thoroughly drenched by rain before encamping. Day's march, 19.17 miles.

May 25.—It commenced raining soon after daylight this morning, and continued until night, making the soil very soft for travelling, and swelling every rivulet to a mountain torrent; so that, although we started at the usual hour, and did not encamp until late, we made but 7.99 miles; and, although we built several bridges in this short distance, several of the gentlemen were thrown into the swollen streams, their riding-animals being thrown down by the force of the water; but this bathing was of little consequence, as we were all thoroughly drenched from early morning until sundown. We remained in camp on the 26th, for the purpose of observing the eclipse of the sun, for longitude, for which we were very anxious, all our previous efforts having proved so abortive. But the morning was unfortunately very cloudy, and we failed in seeing its commencement, and were no more fortunate at its termination, the sun only occasionally breaking through the clouds during the day, and being too much clouded for the exact observation of its termination. The day was considerably darkened and chilled by the obscuration. Our camp is magnetic west from the point where we entered this valley, near a small lake, six days since.

May 27.—We continued along the base of the mountains, crossing several small streams, and emcamping, after a march of 13.93 miles, at the mouth of a narrow ravine by which an Indian trail passes over the mountains. I ascended it quite to the summit, overlooking again the valley of the Humboldt river, towards which several small streams were seen flowing from mountains west of that on which I stood. On the peaks of two or three of these mountains, only, could I see snow, and on these in but small quantities. The country, except by the course of the Humboldt river, looked very broken and difficult to cross. This pass is only fit for a mule-path, as the ascent by the most advantageous line is 1,200 feet in the first three miles.

The lake spoken of before, several miles in extent at high water, we passed to the east to-day. It is lined with grassy marshes on the west, and apparently by sage-plains on the east, and is very shallow, the shoals appearing here and there above its surface. From my position on the summit of the mountain I could see a high shore-line across its southern end, dry and easily crossed; but it is immediately succeeded to the south by ponds and marshes of considerable extent. Several Indians—Diggers—whom we met, collected a score of their friends, and accompanied us to camp. They are better clothed (in skins) and less afraid of us than those we have before seen. They are accompanied by but one squaw, who has a child a year old, of which she is very fond, and its father plays with it in its new finery—a sight I have never before seen among wild Indians. An equally strange sight was that of the only horse possessed by the party, packed with their effects, surmounted by the child, while the father walked and the mother carried no burden. Several of our men are quite ill with fevers.

May 28.—I engaged an Indian to accompany me to-day in order to gain from him such information of the country as he possessed; but he soon deserted and returned, with two companions who accompanied him, to his people. From the base of the Humboldt mountains a very large number of fine springs burst out and flow into the ponds and marshes to the left of our trail: all the water indeed—and it is a large amount—with the exception of one or two small creeks of this portion of these mountains, bursts in springs from their base. In a single mile I counted fifteen, any one of which would have been a remarkable spring in another locality; but one of them was, even here, remarkable, both in volume and beauty. It bursts from the base of a vertical rock of blue limestone, nearly 50 feet in height, in the face of the mountain, in a single stream like the escape of a subterranean river, and pours down in a foaming white sheet over detached rocks for 40 or 50 yards; and thence continues on in a rapid limpid stream, 15 feet in width, and one in depth. The streams from several of the other springs were nearly as large, but none compared with this in beauty. The numerous ponds and marshes formed by them seem to have no outlets; at least we could discover no stream flowing from this valley, which receives a very large amount of water, all of which must be carried away by evaporation.

Twenty miles from our morning camp we turned west, and began the ascent of a pass which an Indian described to us by placing his open hands side by side, and gently separating and elevating them, indicating a broad open depression in the hill or ridge rising to high summits on either side. Its width is six or eight miles, and it is a very superior natural wagon-road, for which it has been used considerably in the early days of emigration to California, the Hastings road passing over it. It is 5.18 miles from the eastern plain to its summit, which is covered by a fine growth of cedar, and an equally fine growth of grass. The descent is also broad, and ten miles in length to the western base of Humboldt mountains to where the southern branch of Humboldt river flows past, which is followed by Hastings' road to the junction of the north fork. We encamped, after a march of 35.11 miles, at a late hour, our dinner not being served until 10 o'clock at night. The valley of this creek is uninterrupted to the eye from Humboldt river far to the south.

May 29.—We travelled four miles over a field of rank sage, and entered a dry, grassy ravine from fifty to one hundred and fifty yards wide, leading to the succeeding summit, 6.83 miles from our morning camp, whence we descended by the same cañon ravine to the succeeding plain, some fifteen miles in extent, enclosed by mountains to the east, south, and west, and by consid-

erable hills to the north, and is therefore a "basin," in the centre of which, at times, if not permanently, there is a respectable-sized lake. We crossed the northern end of this plain, where it is covered with rank sage from three to five feet high, and proportionably large, our course being directed to the most favorable western depression in the succeeding range, which we ascended slightly, and encamped, after a march of but 16.02 miles, in fine fields of grass upon the banks of a small rivulet.

Last night was quite cold, snow falling on the mountains, and a few flakes in the valleys, and ice forming on the water; and at sunrise, the thermometer stood at 26°. The party were wrapped in their overcoats during the whole day, and fires are pleasant this evening. But, notwithstanding this indication of the climate, the blades of grass are eighteen inches long.

May 30.—We passed the low summit at the depression near which we had encamped, finding a small creek flowing west, which we followed towards the next valley until the hills confined it within too narrow limits to admit of our passing in its ravine; at the same time, the mountain rose high and abrupt to the west, covered with a thick growth of cedar, interspersed with a few small pines, through which we were obliged to cut a road to its summit. The western descent, for a thousand feet, was very steep, and intersected by vertical ledges of metamorphic rocks, broken and fallen at intervals, enabling us to descend with our wagons, when we again returned to the creek, on which we encamped at the termination of the mountains, surrounded by an immense growth of sage interspersed with grass. Day's march, 10.44 miles. The night was cold, ice forming in our tents.

May 31.—We entered a large valley, extending north to Humboldt river and far to the south, and covered with sage, except in a few spots white with incrustations of salt. The chain of mountains to the west is not so elevated as those passed heretofore; but a high, snowy peak, and the sharp crest of a considerable range, are seen far to the south, dividing the valley. Several small creeks were crossed flowing into one main one, which descends towards the valley of the Humboldt. Reaching the western mountains, we came to a small stream of excellent water descending from the pass we were approaching, and ascended two miles, when we encamped, having travelled 21.94 miles. We saw but little grass during the day, but it is abundant among the sage on the hills about our camp.

A single Indian visited us this morning, and two or three were seen during the day industriously employed in catching small ground-squirrels or gophers, upon which they subsist to so large an extent. They are very numerous, and in fine condition at this season of the year. The Indians shoot them with blunt arrows, catch them in ingeniously contrived "figure-four traps" set at the mouth of their burrows, and dig them out of the earth with their hands; and it is not unusual to see them carrying forty or fifty, the reward of a single day's hunt. Forty Indians (Diggers) were gathered at our camp at sundown this evening—all males, and generally unarmed. I ordered camp-kettles of soup for their supper, and made them presents of a few knives and other articles, which put them in such good humor with themselves and our party that they spent the entire night at the fire assigned them, under the eye of the guard, singing and rejoicing, and annoying us by their grunts and nasal sounds, of which all Indian singing is made up—sounds anything but agreeable to civilized ears. At daylight their number was increased to fifty; and as I arose, the arrival of a chief was announced by the oldest acquaintance we had in the band, and he was soon paraded before me to receive the lion's share of the bounty in which he had not participated the previous evening. I covered him and his son, a small boy, who stood by his father's side, in scarlet, greatly to their delight. The claims of those who had arrived during the night were next urged; but I had no time to attend to their wants, and informed them that they would receive no more—"Kay-wit," in their miserable language—when their importunities ceased. Their wigwams—wick-ey-ups, as they call them—are superior to those we have recently seen. They are bee-hive shaped, four feet high, and partially covered with grass. The opening of every one that I have seen in the Basin is towards the northeast, an indication of the prevalent direction of the storms.

June 1.—Two miles and a half, by an easy ascent for wagons, brought us to the proper summit of this pass, to conduct us to which, one of the Indians constituted himself guide, running before my horse and pointing out every stone and bush that he was to avoid, while several others were occupied in catching rats along our path; but the main body preceded us a short distance, and appeared in great haste, which excited my curiosity, and I rode forward to discover the cause of it, from which it appeared that, as a matter of policy, or a precaution to prevent being despoiled by robbery of their wardrobes, in visiting us the previous evening, they had, each for himself, made a cache of his effects under separate bushes, and for the same reasons they were now hastening to remove them from where we were about to pass. It was indeed a novel and ludicrous sight of wretchedness to see them approach their bush and attempt, slily, (for they still tried to conceal from me what they were about,) to repossess themselves of their treasures, one bringing out a piece of an old buckskin, a couple of feet square, smoked, greasy, and torn; another a half dozen rabbit-skins in an equally filthy condition, sewed together, which he would swing over his shoulders by a string—his only blanket or clothing; while a third brought out a blue string, which he girded about him and walked away in full dress—one of the lords of the soil. With these simple wardrobes they were all soon reclothed, and we arrived at the same time at their lodges, deserted by their women, and upon the top of the pass—that is, to where a respectable stream rose and flowed to the west. But owing to the formation peculiar to so many of the mountains in the Basin, and upon our continent generally, we had but just commenced the ascent necessary to its passage in its natural state. For, though the streams continue to flow to the succeeding valleys, which are open and easily descended, frequently for miles, the mountains still continue to rise to the west, and the valleys are again closed up by their close proximity, and the streams break through the last and highest ridges in deep, narrow, rocky ravines and cañones, which terminate abruptly to the west. This was the case in this instance, and we were obliged to ascend a thousand feet higher before commencing the descent, and were then obliged to encamp, and put all our well men—for we had several sick with rheumatic fevers—to work to level down a roadway on the side of the ravine we were descending. From the top of the valley the view was extensive. To the west a small valley, containing small ponds of water, sweeps off to Humboldt river, and is succeeded by numerous mountain ranges of limited extent, and by two large ranges upon which there are still large banks of snow. This mountain is characterized by large masses of beautifully colored quartz, and we therefore gave it the name of Quartz mountain, although it is chiefly composed of dark metamorphic rocks. To the pass, Dr. Shiel, geologist, gave the name of Agate, that stone being profusely scattered about in large blocks. Day's march, 6.83 miles.

June 2.—Owing to sickness among the men, with new cases of rheumatic fever daily occurring, it was necessary to remain in camp to-day, during a heavy fall of snow, from 6 a. m. until noon, when we proceeded to the foot of the pass, 2.65 miles, and encamped; but during this short march we were thoroughly wet by a shower of rain, and a second swept over us after we had encamped. This pass, though easily ridden up, would be in some parts very difficult to ascend with wagons. The valley in which we encamped does not exceed nine miles in width where we entered it, but a little to the north the mountains trend to the east and west, and it becomes broader, but again becomes narrow before joining the main Humboldt valley. Several small streams descend into it, forming the grassy ponds already described. Two or three varieties of artemisia constitute its chief vegetation. Its soil is very light and friable; the track of a single Indian crossing it being plain and distinct.

June 3.—A cool and pleasant morning. Crossing the valley of our morning camp, we ascended a range of low hills of altered rocks, which could be easily passed around to the south, and then crossed another small valley, from which a creek flows into the one first crossed, and passed over a second range of hills, as easily turned, and encamped on a creek which descends to a small pond two miles distant. Scattered over the hills there are a few bunches of wheat-

grass, and on the stream a narrow margin of the broad-bladed grass of the country, and sage supplies us with fuel. We see daily a few varieties of wild flowers scattered along our path. The rocks in the vicinity of our present camp are a coarse, crumbling granite.

June 4.—It was again impossible to cross the mountain, (at the foot of which we had encamped,) by the lowest depression in it, on account of a narrow ravine with steep sides and rocky projections at short intervals, and large stones in the bed of the creek which trickles down it. We therefore turned north, following for some distance the ravine of a large stream coming from high peaks in that direction; but it became narrow and miry, obliging us to leave it and wind round from hill to hill until we reached the summit of the mountain, which was itself very springy and miry, and we passed a small pond on its narrow summit. There are no trees upon it, but a few scattered cedar-bushes and a luxuriant growth of bunch-grass. From the high peaks near the pass the valley of the Humboldt was seen, 25 or 30 miles distant, to which the valley to the west extends. The descent was more steep, springy, and miry, than the ascent, and filled with out-cropping strata of altered rocks, in the passage of which two or three of our wagons were broken. By the wagon path it was 8.44 miles from our morning camp to the top of this pass, with a difference of level of 2,019 feet, the altitude of the summit being 7,315 feet. We encamped near the succeeding valley, 3.04 miles from the summit, and 1,667 feet below it.

June 5.—In the valley which we crossed this morning there were numerous ranges of hills, and twelve miles to the west a low, bluff mountain, around the north end of which we passed, coming upon a small lake of brackish water surrounded by miry, desert plains, in all respects like those immediately west of Great Salt lake. Crossing the foot of these miry plains, from which the sun was reflected with great power, we encamped at the mouth of a ravine in the succeeding mountain, from which a fine stream of cold water descends. In the first valley crossed, no vegetation was seen except artemisia, and the soil was alternately light and dusty, and smooth hard clay. The mountain at camp is formed of altered rocks and of a hard, blue limestone. Day's march, 30.10 miles.

June 6.—We passed around the north end of the mountain of our last camp, through a broad depression two or three miles in width, in which there were fine springs of water and a respectable growth of cedar. The ascent of our road was inconsiderable. On the north of the passage stands a small mountain, which sends out a high spur to the southwest, which I ascended, and from which the view was extensive. Mountains succeed mountains rapidly, and the valleys become small and irregular. The one which we were entering sends out a small stream to Humboldt valley, and is bounded by a high, snowy range to the northwest, which gradually subsides towards the south, where it trends to the eastward and unites with the one we were passing—the rocky strata of which dip from each side towards its centre. We encamped in fine fields of grass, with sage for fuel, at the foot of the mountain which trends eastward. Two or three Indians were seen during the day, which was fine with a pleasant breeze, with thunder-showers in the mountains. Day's march, 14.12 miles.

June 7.—Guided by the Digger Indians, who call themselves Pah-Utahs, however, we passed easily over the mountain at our last camp through luxuriant fields of grass and sage. The ascent from camp was narrow only for a hundred yards, the hills sloping easily upwards; and in the mountain there was a broad depression, followed by a descending plain 75 yards in width, at the foot of which there are fine springs of water which we passed as we entered the succeeding valley, which is ten miles broad, and extends to the north to Humboldt river, but is shut in to the south by mountains. The soil of the valley is friable and dry, supporting only a small variety of artemisia. Leaving the valley, we encamped well up a ravine in the succeeding mountain. This pass is grassy, well watered, and easy to ascend to the summit. There are a few small cedar-bushes only in the mountain, but sage covers all the hills. Indians were digging roots about us, which were of the size of ground-nuts, with a pleasant taste. A few presents made them happy. Distance, 20.57 miles.

June 8.—Leaving camp at 6 o'clock this morning, we passed the summit of the mountain, and descended the opposite slope on the banks of a fine creek which flows into a desert plain in the southern part of the succeeding valley. This valley is ten miles wide where we entered it, and extends to the south and west entirely around the next western mountain-range, which is elevated and quite snowy towards the north, where it is terminated by a high peak marking the southern border of Humboldt valley. The soil is light and covered with artemisia. In entering it we changed our course considerably northward, and passed over a low spur of the western mountain, where it descends to the valley of the Humboldt river. In entering this plain, we returned to the proposed line for the railroad. The valley of the Humboldt, as seen here, is from eighteen to twenty miles wide, its soil very light and friable, with extensive districts of sand, more or less covered with the several varieties of artemisia, which occupy so large a proportion—at least nine-tenths of the plains—of our territory between the Rocky and Sierra Nevada mountains, and characterize its vegetation. To the south of the river, and for a short distance to the north, the mountains are generally similar to those we have so recently crossed, which run out as they approach the valley. Many of them do not exceed twenty or thirty miles in length, and are easily passed around upon the general level of the plain. They are generally very narrow, and, in their elevation, seem nowhere to have disturbed the strata of the plain above which they rise; or, more properly, the earth of the plains—for they are without rocks—seems to have been deposited since their elevation.

Four miles from the mountain we reached the river, and encamped. The river-bottom is a mile wide, the stream, just level with its banks, winding, from side to side, to where the second banks or bluffs, twenty feet high, rise to the level of the main plain of the valley. Willows line the stream in many parts, but trees are nowhere seen on the Humboldt. Its water, even at this season, is not superior, and becomes less so as you descend it, and as it subsides after the spring rise. It is now 40 yards wide when all collected in one channel, and eight feet deep, flowing with a moderate current. There are no fish in this part of it larger than minnows. The width and character of the valley as here given extends as far as we can see, many miles above and below, and is precisely like the portion we entered at the foot of the Humboldt mountains, and such is its general character. It is infested with mosquitoes and sand-flies. The day has been very pleasant. March, 30.26 miles. The altitude of camp above the sea, 4,141 feet.

June 9.—We moved camp but 6.80 miles down the river to a point selected for crossing it, where it has no bottom-land upon it. These low lands being very much overflowed at this season, and miry, are entirely impassable for horses or cattle; and many arriving here in a weak condition, are annually lost by emigrants from becoming mired. But one of the chief causes of the loss of cattle by emigrants upon this stream, is allowing them to eat the grass in the river-bottom, which is extremely unwholesome. The more experienced stock-drovers to California, send their cattle back from the river to feed on the nutritious grass of the hills; but, as these are frequently distant from the road and from water, it is only by experience that men learn its importance.

CHAPTER IV.

From the crossing of Humboldt river, via the Madelin Pass, to the junction of Fall river with the Sacramento, and back to the shore of Honey lake, eastern base of the Sierra Nevada—June 10 *to July* 4, 1854.

Crossing Humboldt river.—Droves of cattle and sheep.—Lassen's meadows, and termination of the western course of the Humboldt river.—Country and passages to the west.—Willows and water.—Mud lakes.—Noble's road.—Railroad grades.—Mud lakes, or plains and deserts; their passage.—Frémont's trail of 1844.—Similarity in geological character of some of the mountain spurs and plains.—Examination of the Sierra Nevada; their broad, massive, and terrace character.—Marshes, ponds, and stony surface.—Indians.—Madelin Pass examined.—View of Mount Shasta.—Grades and altitude of pass.—Country southeast of the broad plains of Madelin Pass.—Light, miry, and stony soil.—Indians.—Basin character of the broad plains of the summit of the Sierra.—Game.—Error in location of Feather river on the best authenticated maps.—Forests.—Descent to Round valley; waters of the Sacramento.—Practicability of this descent for a railway.—Indians, (Pah Utahs?).—Grave.—Emigrant road (Lassen's) and Oregon road.—Source of the Sacramento; its first cañon.—Grades.—Pitt river; Pah Utah or Digger Indian women digging roots.—Making arrow-heads.—Indian pantomime.—Impracticability of descending the Sacramento with wagons; its examination to the mouth of Fall river.—Impassable volcanic rocky fields.—Character of the river banks.—Timber.—Grades.—Reference to itinerary, from July 15 to 21, for a description of the Sacramento below Fall river.—Recrossing the Sierra Nevada.—View of peaks of the coast range.—Graves of emigrants.—Pine creek.—Noble's Pass road.—Summit creek.—Susan river.—Eagle lake.—Roop's farm in Honey Lake valley.

June 10.—We crossed the river by a small wagon-boat brought with us for the purpose, and descended the stream 3.51 miles to camp. Fine droves of cattle, which had been wintered near Great Salt lake, passed to-day on their way to California, and one or two large flocks of sheep are but a few miles behind them. Latitude of camp, 40° 42′ 03″.

June 11.—Our last camp was in a large bottom of coarse grass—the last found on this river above its sink—known to emigrants as Lassen's Meadows, in which the river terminates its general western course, and turns south for 40 miles, where it reaches the marshy lake in which it disappears. Immediately north of the meadows there is a detached mountain range, a few miles in length, behind which there is said to be a favorable passage to the west, leaving the river, of course, a few miles above where we returned to it, but in sight. The same passage is entered by the west end of the mountain by a northwest course from yesterday's camp. It is by this line that Noble's route to California, followed to some extent by emigrants, leads to Mud lake, and it is believed to be the most favorable route for reaching that lake from the river; but its eastern portion did not appear so favorable to us as one further to the south, which we followed after ascending the highest mountain in the vicinity, and examining the connections of the respective passes westward. By the one we followed we descended the course of the river for 9.64 miles, and then bore off to the southwest over the foot-hills of a mountain just west of this part of the river. Still further to the south, the country becomes more open, and no obstacle could be seen to approaching Pyramid lake on the general level of the Basin; but this would have taken us too far to the south for our present purposes, if it could be avoided, and we therefore followed what appeared the best route. The soil of the valley and foot-hills was of ash-heap friability; but as we ascended the broad, open mountain depression it became firm, being formed from the disintegrations of granite rocks. The ascending grades to the summit of this pass are, for the first 9.64 miles from our morning camp, 16.20 feet per mile; but, from the formation of the hills, the distance can be increased to diminish the succeeding grades, which average 23.20 feet per mile for 7.86 miles; 64.30 feet per

mile for 6.93 miles; and 97 feet per mile thence to the summit, 5.50 miles distant. The width of this depression, in its narrowest part, exceeds one and a half miles.

We were obliged to leave it, however, to find water and grass, encamping on a granite peak to the south, and several hundred feet above it, where the grass was abundant, and a small spring furnished a sufficient supply of water.

June 12.—The pass to the west is equally as broad and open as to the east, with a descending grade of 87.20 feet per mile for 10.55 miles, and of 30.50 feet to the mile for the next 4.68 miles; and thence to the succeeding valley, 1.85 miles, 73.50 feet per mile. This valley extends far to the south, and doubtless to the east to Humboldt river, passing to the south of this mountain, and west to Pyramid lake. It extends, however, only 12 or 15 miles to the west, opposite the point where we entered it. The western portion of it is entirely barren, and in the spring is doubtless covered with water. To the north the plain of the valley ascends considerably, and becomes narrow, not exceeding two miles in the narrowest portion. It was late in the afternoon when we entered it, and we could nowhere see any indications of water. We therefore turned northward, and were gradually approaching the west side of the valley when we discovered a bunch of willow-bushes on its east side—an unfailing sign of water in this country—where we found a small spring, and scattered grass in the plain two miles below. The plain was level for 2.55 miles by the path we followed, and ascended 21 feet per mile for 8 miles to where we left it to encamp. The mountains about us are not elevated enough to retain snow at this season, and are very dry and destitute of timber. The rocks in the higher parts are coarse granite, but lower down are shale, and hard dark-red trachytic strata. The day has been cool, with a high southwest wind and slight showers. Day's march, 28.75 miles.

June 13.—From our morning camp our path lay west to a depression, two or three miles wide, in the succeeding ridge, from which we descended northward over the base of hills extending towards the western valley, directing our course to an open passage in the next western range, at the foot of Mud lake, or rather through which that lake extends, to the foot of the Sierra Nevada. Finding, however, that we should not be able to reach it before night, it was necessary to leave the barren sage plain, and ascend the mountain to the west, to find a camp. But although the grass was abundant, we were unable to find water. Several slight showers during the day, however, prevented great thirst, and one at evening moistened the grass for our animals. The most eastern of the miry plains, called Mud lakes, lies 11.75 miles directly north of the camp. Its southern border is followed by Noble's road, which follows one of the most favorable lines by which the passes we are approaching in the Sierra Nevada can be reached from the east, and in the event of future surveys being conducted in this part of the basin, it is worthy of examination. In crossing the valley which extends to this lake, in approaching camp, we passed over a high mass of rolling hills, which should have been avoided by extending our course to the west in the earlier part of the day; or in leaving the preceding pass, we should have maintained our level by travelling on the east side of the valley, and thus have avoided the descent and rise indicated by the profile, for though the grades are not heavy, they are to some extent unnecessary. As before stated, the depression crossed in the ridge this morning is broad, and can be ascended by a line at least twice as long as the direct one followed by us, which would make it entirely a practicable grade in its unimproved condition for a railroad. From the centre of the valley east of that pass, we ascended 69.80 feet to the mile; and thence to the summit, 1.37 miles, the ascent was 207 feet to the mile. For 2.55 miles west of the summit, the descent was 40.30 feet per mile; and the average ascent for the next 7.04 miles, 44.40 feet per mile; while the change of level indicated by the barometers in the succeeding 2.54 miles was but 43 feet. Day's march, 24.12 miles.

June 14.—We crossed the mountain on which we had encamped, immediately to the west, and descended to a branch of Mud lake. The soil of these plains is very light, and our animals sink quite as deep in many of the parts, dry upon the surface, as in the wet and miry portions. The name of *lake* is liable to mislead you in regard to the character of these mud-

flats. It is true, there is a small sheet of water upon the surface of a small portion of the most eastern of them, and upon the most southwestern also; but their general character is precisely that of the Desert west of Great Salt lake—a plain of mud, more or less miry at intervals, destitute of vegetation, with a surface, especially when recently moistened by rain, presenting at a little distance a perfect resemblance to a sheet of water. It is here and there incrusted with salt, but not to the extent of the desert referred to. The first branch of these plains which we crossed was 6.90 miles in width. At this point we crossed Frémont's trail of 1844, leading from the Boiling springs to Pyramid lake. We then travelled along the north end of one of the ranges or spurs of mountains terminating in these plains. I experienced great difficulty in ascending it a few hundred feet on horseback, its composition being in many parts precisely that of the plain, into which, of course, it is washed by every shower. Granite is, however, found in the same mountain, and vegetation in some parts, but there is none upon the friable surface. It was late in the day when we arrived on the eastern border of the second branch of the plain, and it was very doubtful whether we could cross it. There was no alternative but to try it, however, and sleep in the mud if we failed; for, although on a lake, we were without water, nor could any sign of it be discovered, nor of grass. Taking a few men with me, therefore, I at once set off, leaving the party to follow with Captain Morris, if I should not turn back in a short time. But although the road was heavy, we experienced no difficulty in crossing this branch of the lake for ten miles to the foot of the Sierra Nevada. The sun was bright, although the day was very smoky, and the reflection severe upon our faces and eyes. When in the centre of the plain, we were gratified by the sight of bushes and of green vegetation in the mountain we were approaching, indicating the position of springs and of small streams; but the streams did not reach the lake, and we experienced much difficulty in ascending to them, as they were upon a terrace, in front of which the ascent was very steep, and so covered with blocks of trachytic rocks, that it was only after great exertion that our animals were driven over them to water and grass. We were here upon the Noble road, which follows the north shore of the lake by the Boiling springs. In descending to Mud lake north, from the valley east of our morning camp, the grade is 76.60 feet per mile for 11.75 miles, and thence to our present camp, or indeed to any point upon the borders of these plains, the change of level is merely nominal. Day's march, 25.27 miles; altitude above the sea, 4,118 feet.

June 15.—I remained in camp to-day to refresh our animals and give the party rest, its severe labors from sunrise until sunset every day, and frequently until midnight, with the men on guard every third or fourth night, requiring relaxation.

June 16.—In order to discover a practicable railroad pass, if possible, in the Sierra Nevada—this portion of which had never been explored—I determined to examine every opening and depression which could be seen to the east, commencing with the northern, and proceeding towards the south—determining not only the merits of each, but establishing their comparative value. The first of these openings we reached by turning gradually westward three miles south of our last camp, and crossing a branch of Mud Lake valley, 8.85 miles to its foot. I there entered a level, narrow ravine, varying from 50 to 200 yards in width, and more or less winding for six miles. Its walls are precipitous, and at a few points vertical. Large rocks lay scattered about its bed, preventing its use by wagons, and ours were sent further to the north over the hills, but descended to the creek to encamp, having marched but 15.20 miles; our ascent by the course of the stream being but about 200 feet above Mud lake. The mountains here are thoroughly trachytic, and many of the rocks partake of a volcanic character—black, red, and white in color, and porous in their formation.

June 17.—Fallen rocks, thick willows, and a miry soil prevented us from following the ravine, the sides of which were also difficult to follow, being constantly broken by side ravines, as deep and nearly as large as the main branch—the rocky sides of which vary from 50 to 200 feet in height, and are too steep to be ascended on horseback. But as its course was sufficiently

direct and its ascent gradual, it was necessary to examine it still further; but it began to rain at an early hour of the day, and we encamped, having advanced but 3.78 miles.

June 18.—From our last camp we left the ravine with the train, and, by a rapid ascent and winding course on its southern side, in two miles reached one of the broad terraces which characterize the formation of this portion of the Sierra Nevada. Crossing this terrace for 1.50 miles, we again rose to a terrace elevated considerably above the first, and then continued to the summit of this part of the mountain by ascending to successive terraces, approached by steep ascents of but a few yards in length. These terraces are more or less broken by deep rocky ravines. To the north of the one we were examining, the terraces rise still higher and more broken. The character of the summit of the mountain is, however, broad and massive, and, when once gained, easily traversed in any desired direction.

The ravine itself above our last camp soon became divided into several branches, and the ascent towards its termination, for considerable distances, exceeded 190 feet to the mile—a grade that could not be diminished by any line that we could discover, to which the labor of several days was devoted. We encamped six miles west of the point at which we reached the broad summit of the mountain, and a short distance west of the termination of the ravine examined, on the borders of a marshy, grassy pond, into which a few springs and small rills are discharged from neighboring hills. This grassy marsh—and the Sierra Nevada is covered with similar ponds—is a mile in width by two or three in length, from which we could nowhere discover water discharging. The whole mountain surface is covered with small angular stones, which in some places are packed in drifts and heaps, over which it is difficult to ride; and the steep edges of the terraces are formed by the outcropping strata which underlie the plains above. Bunch-grass is abundantly scattered over the hills, and a few branching cedar-bushes are seen. There is in no direction more than a handful of snow visible.

Several Indians, calling themselves Pah-Utahs, visited us and received small presents.

June 19.—The examination of the country already described was continued to-day, while the train and main party, under Captain Morris, moved south and west, crossing the marsh spoken of yesterday, and passing over a ridge of low rocky hills, entered Madelin Pass, the broad valley of which sweeps off to the east, encamping after a march of 9.30 miles. Smoky creek, a small stream, descends to Mud lake through the valley, which is covered with sage, grass, and stones—the soil being as light as upon the miry portions of the Basin. Latitude of camp, 40° 44′ 12″.

June 20.—We descended 7.25 miles towards Mud lake and encamped where the valley, which is ten miles wide in its broadest part above, becomes narrowed again to a mile in width, whence it continues to the eastward between hills rising and sloping back to the height of a few hundred feet. Our camp is upon one of the great terraces of the mountain. This terrace is broken in the centre to the east by deep ravines, with steep rocky walls. It is only with the greatest difficulty that our animals can travel over the light soil and rocky surface of the valley. The day has been delightful. Altitude above the sea, 4,914 feet.

June 21.—Captain Morris, Mr. Egloffstein, Mr. Snyder and myself examined the lower portion of this pass to-day. It was 13 miles to the eastern base of the Sierra Nevada, in the plain of Mud lake, to which we approached within six miles—obtaining an unobstructed view back to the point at which we turned west to leave its shore on the 16th instant. Immediately above the plain Smoky creek breaks through a mountain ridge, three miles in width at the base, in a pass varying in width from 100 to 150 yards, and at one or two narrow points not exceeding 50 yards. Its walls are of coarse, crumbling, metamorphic rocks, greatly cut and broken by small rents and side ravines. They rise, not vertically, but at points very steep, from 50 to 200 feet on the south side, and still higher on the north, swelling up, two miles back, into an elevated mountain ridge. Thick willows are in the way of passing easily up the stream, which is followed, however, by a wagon-road for a mile, which then leaves it and passes over the hills on the south side to the head of the gorge. For two miles above this point the wagon-road

ascends a gently opening valley. It then leaves it, ascending a branch of Smoky creek to the southwest. The valley of the Madelin Pass at this point is half a mile in width; and a short distance above, it is a mile, but afterwards becomes a narrow ravine, with rocky walls, often vertical. On the south side the wall at once rises to the level of the terrace extending to our camp, and a railroad could only ascend that side of the pass by being cut along it; but on the north side, for seven miles above the gorge, there are no terrace walls, but the hills which set down into the valley afford a favorable site for ascending the pass. Above this point the terrace wall is found on the north side of the little valley also, but can easily be avoided in the construction of a road for which nature has already done much of the grading.

June 22.—A cool, bright day, with a gentle breeze from the southwest. The general width of the pass above our morning camp varies from four to six miles, but becomes more narrow as we approach its summit, where it does not exceed two hundred yards in width. But the hills and mountains rise gently and gradually in all parts above it, and advantage can be taken of them to increase the distance and diminish the grade of a road to a very considerable extent. It was 9.89 miles to the summit by the direct route we followed. It is broad and rocky at the summit for three-fourths of a mile, and then gradually descends for three or four miles to a broad open plain, too level for the eye to detect its inclination. Large mountain ridges and peaks rise above this plain in all directions, but are nowhere snowy. A single snowy peak and a snowy ridge, however, are seen to the northwest, considerably elevated above the intermediate range. The extensive level plain (at the head of this pass) is ten or twelve miles wide, north and south, by forty in length, east and west. The most remarkable feature in this part of the Sierra Nevada, and a conspicuous landmark, is an elevated conical peak, standing immediately on the eastern limit of this plain, and directly in the line of the Madelin Pass in ascending it from the east. The pass winds immediately around its northern base. Some of the gentlemen of the party ascended it, and were gratified with the magnificent view it afforded; of which the snowy Mount Shasta, to the west of the Sacramento, was the striking feature. Its elevation is from 2,500 to 3,000 feet above that of the summit of the pass. We encamped at the western base of this peak, at springs and meadows of grass.

The grades indicated by our barometers for the ascent of this pass from the valley of Mud lake are as follows: To the head of the gorge, 3 miles, 41.60 feet per mile; and for the succeeding 3 miles, 61.30 feet per mile; and 59.20 feet per mile for the next 2.50 miles, followed for an equal distance by a grade of 74.80 feet to the mile. The ascent for 3.56 miles above this point is but 31 feet, followed by a grade averaging 76.10 feet to the mile for 1.55 miles, and of 78.20 feet per mile for 1.56 miles; and for the succeeding 1.55 miles, 94.80 feet per mile; then for 1.56 miles, the grade is 50.60 feet per mile, followed by one of 100 feet to the mile for 1.32 miles, and of 30.30 feet per mile for 0.79 mile to the summit of the pass, the altitude of which above the sea is 5,667 feet, and the entire length of the ascent 22.89 miles; and the total difference of level between the extreme points, 1,172 feet. From the summit of the pass westward, the descent in the first two miles averages 23.50 feet per mile, and 31.80 feet per mile for the next 1.98 miles; and for 1.94 miles, 67 feet to the mile; and thence to camp, 3.85 miles, the descent averages 46 feet per mile. Day's march, 19.66 miles. Latitude of camp, 40° 48′ 46″ north.

June 23.—The train proceeded a little south of west, skirting the base of the mountains to avoid the miry banks of creeks descending into the plain, forming small grass-fields and miry marshes. Passing an isolated butte to the right, it crossed a small plain extending to the southeast and encamped, having travelled but 10.37 miles. I proceeded, at the same time, with Lieutenant Baker, Messrs. Egloffstein and Snyder, to the southeast from our morning camp to the plain just mentioned, which appeared to lead to a favorable descent to the valley of Mud lake, near its connection with Pyramid lake. Our altitude on the summit of the Sierra was 100 feet less than at the top of Madelin Pass; and for several miles below, the descent was broad and unobstructed, except by surface-rocks and stones; but the labor of riding

over the miry (dry) soil so often mentioned, was severe, not only for our animals, but for ourselves. Five miles below the crest, the country became much cut up by ravines, and was falling off so rapidly, 250 feet to the mile, that we did not deem it necessary to proceed further, but ascended a rocky mass and obtained a favorable view of a route leading from the south end of Mud lake to the west, which had attracted attention when we were approaching the Sierra from the east. Descending from the mountain near us were several small streams, forming a grassy pond at the foot of the descent; and beyond this a broken ridge was followed by the pass just mentioned; still to the south of this, a high range was seen, upon which there was considerable snow.

In our outward trip we surprised several Indian families. They were much frightened at our appearance, especially the women. I invited the men to accompany us, and made them presents. On our return the women had all disappeared, but the men accompanied us to camp, where we arrived at sundown, after a ride of thirteen hours. South from our camp the mountains rise gradually, but to no considerable height. Cedar was scattered along our path to-day, rising to the height of only 40 or 50 feet, but the largest of the trees were two feet in diameter.

June 24.—I determined to cross to the west the broad plain upon which we came at the head of the Madelin Pass, and which would be followed by a railroad crossing this part of the Sierra Nevada. As before stated, this plain to the eye is entirely level, and although several small creeks flow into it and sink, no water is or can be discharged from it without (first forming a lake) overflowing at one of the numerous low gaps in the surrounding ridges. At the time of melting snows, there are many little sheets of water standing upon it for a short time, and even now it is not free from them towards the west. Its vegetation is generally sage, but a few limited meadows of grass exist on its borders. A variety of large snipe and sage-cocks are common, but we saw no evidences of larger game. On the best authenticated maps in our possession, Feather river is laid down as rising far to the north of our present position, and, in its southern course, draining the country which we are passing; and, however well we were satisfied from the formation of the country that this could not be the case, it still indicated the probability of finding a practicable descent, in the direction we were travelling, to the waters of the Sacramento; which is laid down on the maps referred to as having one of its chief sources in a snowy range of no great extent, which has been several days in sight to the northwest.

The day was bright and clear—after the passage of a storm at a distance in the morning—with the usual very high wind from the southwest. The entire march was upon the plain, passing occasionally between low hills; and we encamped near the base of more connected low ranges near the mountains surmounting the plain to the west, which are low and beautifully dark with *forests* of timber—the first we have seen in twelve months really worthy of the name. Day's march, 19.53 miles. The line of profile is direct from our camp of the 22d instant to this point; the distance (across the plain) being 21.9 miles, with but a nominal grade.

June 25.—Taking the most favorable course we could discover, we were forced still to the northwest, passing (upon the plain of yesterday) between two low spurs at first, and afterwards leaving a small lake to the left. We then entered a pass, or ravine valley, a quarter of a mile wide, smooth and gradually ascending for a mile. It then expanded to the width of a mile, and was grassy and smooth, and still rising easily; but it became narrowed to a quarter of a mile in width, and rose more considerably for the last half mile as we approached the summit. The hills or mountain ridges rise gently on either side of the ascent, and are finely rounded and grassy; and that to the left, and the whole mountain at the top of the pass, is beautifully wooded with pine, two, three, and four feet in diameter, rising in fine trunks to great heights. By winding on the hills it would be easy to increase the length of the approach somewhat, and to transfer the grade towards the lower part of the ascent, and equalise it; and the summit can easily be cut to the depth of 100 or 120 feet, diminishing the altitude to be overcome. The descent to the west is at first rapid, and the ravine narrow; but it soon opens to a much greater width, through which a creek descends, at first lazily, but afterwards, as the water

increases, with a free but not rapid current. We passed with our wagons without difficulty down the slopes of spurs of the mountains projecting into the pass, having to ascend and descend these spurs in passing side ravines. The last of these spurs only deserves a remark, as it brought us nearly to the level of the top of the pass, and narrowed the valley of the creek to the width of fifty or sixty yards; but, as it was filled with bushes, it was preferable to avoid it by passing over the hill. Opposite this hill, a deep cañon from the southwest enters, with steep rocky walls. As we descended from it, we entered a valley of a mile in width, still descending considerably as we progressed.

From the summit of the pass it would be easy, for some miles, to carry a railway on the hillsides, descending at pleasure; but further down, this would become more difficult, on account of the curves which the hill ravines would require, but it is still practicable. For this purpose the northeast side is the most favorable; for, although containing the largest number of ravines, they are the smallest, and it is unbroken by cañones. The western descent of the pass is heavily timbered to near our present camp, and there is a fine warm spring, in a basin of rocks, just where we ascended the high spur to avoid the creek. We encamped before leaving the pass, after a march of 21.67 miles.

June 26.—Last night was clear and beautiful, but cool, making overcoats and fires comfortable in the evening. The morning was also bright and clear, with the thermometer at sunrise at 19° Fahrenheit—ice having formed an eighth of an inch thick. The pass again became narrow below camp, and heavily wooded for five miles, to where it opens into a broad plain called Round valley. This valley is twenty miles or more in length, and ten or twelve in width; and several creeks flow into it, and overflowing form marshy lands of large extent. It is everywhere luxuriant in grass, and the mountains around it are heavily timbered. They are not high, but gradually swelling and rolling. High mountains are seen, however, far to the north, upon which there is some snow. In the west, Mount Shasta is a beautiful feature in the landscape; and to the southwest, other beautiful snow-peaks mark the western line of the Sierra Nevada. As we entered the valley, unusually large Indian smokes curled gracefully upwards here and there, announcing the arrival of strangers.

Turning southward, we followed the base of the hills to our evening camp. Indians were seen at some distance as we were encamping, and Captain Morris rode to them and invited them to accompany him to camp. They are short, but muscular and well-made men, calling themselves Pah-Utahs. They were naked and wild, and we could comprehend but few of their signs. Their noses were bored and ornamented with a horizontal bar of shell or bone. Just above our camp was a newly-made grave, from which the earth had been removed, and the clothes stripped from the body of a young man, doubtless by the Indians, who told us that he had died but two days previously and was buried by his friends; which we subsequently learned was true, the party having been here in search of gold.

June 27.—It was 4.76 miles to the south end of Round valley, where we came upon an old emigrant road, (Lassen's) which is said to leave the Humboldt river above the point at which we crossed it, and to cross the Sierra Nevada near the southern line of Oregon, in the vicinity of Goose lake. This part of the road has also been used in travelling from Oregon to California. Its trail is well worn, but at present seldom used.

One of the main sources of the Sacramento river is in the snowy range referred to in crossing the Sierra Nevada, to the north of our path, whence it descends and enters the northeastern part of Round valley, and leaves it at our present station, where it enters a rocky cañon 100 yards wide. The river is from 30 to 40 feet wide as it enters the cañon, flowing with a free current over a bed of rocks. The walls of the cañon at its head are 80 feet high, vertical trachytic rocks at top, with a large talus at the foot.

From our camp of the 24th instant, the ascending grades upon the line explored average, for the first 10.57 miles leaving that camp, 32.70 feet per mile; and for 1.63 miles thence to the western summit of the Sierra Nevada, 92.60 feet per mile, or 26.30 feet if the deep-cut of

120 feet be deducted from the altitude of the pass, which is 5,736 feet above the sea. With the same deduction for a deep cut, the descending grades will average, for the first 2.42 miles, 124.30 feet to the mile by the fall of the stream, or 173.4 feet per mile for the same distance to the west, if the summit be passed without any cut or tunnel; succeeded, for 4.93 miles, by 55.90 feet per mile, and 125.30 feet to the mile for the next 3.67 miles, and 25.30 feet per mile for the following 2.25 miles; while the descent is but 25 feet in the succeeding 2.08 miles, but averages, for the next 1.25 miles, 76 feet per mile, and 19.70 feet per mile thence to our last camp, 8.81 miles; and from that camp to the head of the cañon, 4.76 miles, there is an ascent, by the foot-hills which we followed, to avoid soft grounds, of 27 feet. In this valley our altitude has returned very nearly to that of Great Salt lake, of the lower part of Humboldt river, and of Mud lake; being 4,154 feet above the sea at the head of the cañon.

Rising the table in which the cañon is formed, we came upon an open plain, without timber, six miles in length, by a variable width of from one to three miles, so covered with stones on the east side of the cañon that we passed over considerable mountain spurs to avoid them, and again returned to the plain near our camp. On the west side of the cañon the ground of the plain is wet, and a sheet of water stands upon it, beyond which the mountains rise a few hundred feet; while above our camp, to the east, they rise much higher, and are everywhere fertile and timbered. A single Indian, only, ventured to come to camp; but as I was anxious to learn something of the water-courses of the country from them, I made him presents, and sent him to invite others in, for the hills and plains on the opposite side of the cañon were covered by them. The women were engaged in digging roots, of which they brought us large numbers on the return of the messenger with a dozen of his comrades, who were entirely destitute of clothing, and armed with superior bows of cedar and long reed arrows, strengthened by inserting strong pieces of wood in their centres. They were short, muscular, and well-formed men, but were seriously afflicted with trembling, which they were unable to overcome entirely for several hours. This part of the Sacramento river has been heretofore termed Pitt river; and these Indians, and the bands lower down on it, are called, in California, Pitt River Indians, although they claim to be Pah-Utahs. One of them seated himself near me, and made from a fragment of quartz, with a simple piece of round bone, one end of which was semi-spherical, with a small crease in it (as if worn by a thread) the sixteenth of an inch in depth, an arrow-head, which was very sharp and piercing, and such as they use on all their arrows. The skill and rapidity with which it was made, without a blow, but by simply breaking the sharp edges with the creased bone by the strength of his hands—for the crease merely served to prevent the instrument from slipping, affording no leverage—was remarkable. After completing his work, he performed a pantomime, to inform me of the cause of his cheeks and forehead being covered with tar. He represented a man falling, and, despite his efforts to save him, trembling, growing pale, (pointing from his face to mine,) and sinking to sleep, his spirit winging its way to the skies, which he indicated by imitating with his hands the flight of a bird upwards, his body sleeping still upon the river bank, to which he pointed. The tar upon his face was his dress of mourning.

It is not practicable to descend the Sacramento river with wagons, owing to the mountainous and rocky character of its banks. I determined, therefore, to proceed with a portion of my party to the mouth of Fall river, leaving the remainder in camp until our return, and to ascend the Sacramento from its main valley to that point, after having completed our survey of the Sierra Nevada.

June 28.—We could not travel in the cañon of the river with our animals, and, to avoid a large, rocky ravine entering it from the southeast, we were obliged to leave it for some distance; and to make our day's ride shorter, attempted to cross the country directly to the mouth of Fall river, intending to return by the Sacramento. But almost immediately after leaving camp, the hills, which were high, and all the small ravines, became so rocky and covered with loose surface-stones, that it was difficult to ride over them; and our progress was effectually

arrested by coming upon extensive fields of volcanic rocks, so rough and full of holes that no horseman can cross them. The Indians clamber over small portions of them, but usually avoid them even on foot. We therefore turned in towards the river, and followed its valley to the mouth of Fall river, encamping just above it. Many Indians were seen during the day at considerable distances, but fled to their hiding-places to observe our movements, leaving their flag-roots where they were digging them. The Sacramento cañon preserves the character with which it begins (at Round valley) for six miles, its walls preserving nearly a uniform height above the river. The plain is then surmounted by high, sloping hills, rising five or six hundred feet above it, and the cañon becomes broader, and its walls also more elevated for two miles, to where the river makes a large bend to the north; below this the walls gradually decrease in height, and in two miles the cañon opens to half a mile in width, which it preserves for three miles to the open valley. This open part of the cañon is timbered with oak and pine, through which the river winds, and we rode several times down its rocky banks, from the hills two hundred feet above. Below, or north of the main bend in the cañon, there are two or three angles in it, but it is generally very direct in its course. The highest parts of the cañon walls are two hundred feet above the stream, with large masses of fallen rock sloping from the stream half way to the top. The passage of this cañon by a railroad, carried generally on the terrace on the north side of the river, and descending the side of the rocky hills which surmount it, which is the most favorable line, will be both expensive and difficult; for it will be necessary to blast and remove rocks to a very considerable extent, the amount of which can only be determined by accurate surveys. The average descent of the stream per mile, for 13.74 miles, from the head of the cañon to the open valley, is 39.30 feet; but by following the north side of the river, the descent can be made much longer and easier by descending to the valley several miles further down the river, which follows the base of the mountains until it turns west, when it is overlooked by a plain, elevated 30 or 40 feet above it, extending several miles to the north. A lake of several miles in extent is seen on this plain, from the hills near our morning camp, and Fall river descends it at the base of the mountains surmounting it to the west. Below the first cañon the valley of the Sacramento is three or four miles wide, easily traversed in any direction, and as easily followed by a railroad with a descent of 27.70 feet to the mile.

Just at our camp the Sacramento is twenty yards wide, and so deep that it can only be crossed by swimming; but its current is very sluggish. Fall river descends by a short rapid of foaming white water, from the plain north of the Sacramento, and discharges more water than the latter stream. At the junction, the Sacramento immediately enters a second cañon, very much resembling the first, but of less extent. The mountains rise above it also, as they do above the former cañon, and extend back on the north side to high mountains; but on the south side, after extending some distance into the plain, they diminish in height and sink away into broken rocky hills, and are followed by an extensive field of volcanic rocks, extending through the valley of Canoe creek, or Poinsett river, to Mount Saint Joseph.

The approximate length of this cañon is 8.95 miles, with an average descent of 34.80 feet per mile. Though not so long, it is as difficult and rocky as the former to pass with a railway, and the most favorable line by which to descend it can only be determined by minute surveys. But it is probable that by leaving the river a few miles above the head of the cañon, and crossing the rocky hills south of it, and returning to the river in the vicinity of the mouth of Canoe creek, (although the grades would not be as easy and uniform,) the least labor would be required in removing rocks for its construction, and the short curves avoided, which will be encountered in descending the cañon itself, and that this will consequently be found the most favorable site for the road.

June 29.—Large numbers of Indians were gathered on the opposite bank of the river this morning, but they were evidently afraid to approach us, unless they could take us at a disadvantage, for which they have a noted reputation. At sunrise the thermometer stood at 32°, and at 11 o'clock in the morning in the shade at 80° F. The day was pleasant, but the

atmosphere too smoky to afford distinct views even at short distances. Completing our observations in the vicinity of Fall river, we retraced our steps, and rejoined our companions at a late hour of the day.

By referring to my journal from July 15th to July 21st, during which we ascended the Sacramento, from Fort Reading to the second cañon, the line just traced to the latter point will be found continued to the open valley of the Sacramento, and my northern line of survey complete.

June 30.—I had been so favorably impressed with the appearance of the broad opening in the Sierra Nevada, at the south end of Mud lake, as seen from several points, that I had determined, on leaving them, to return to the eastern base of the mountains and examine it. With this object, we therefore followed the old wagon road, near which we had encamped, in a general direction for several miles to the south. It led from camp immediately over a high ridge, affording an extensive view of the mountain country around us, and of a few peaks of the Coast range, seen through low openings in the western ridge of the Sierra Nevada. But the smoky state of the atmosphere was such that no distinctive features or outlines could be traced in the distant scenery. Seven miles from camp, we entered a forest of majestic pines and cedars, through which we travelled for the remainder of the day, but with occasional open, grassy spots, on one of which we encamped after a march of 15 miles. After the high ridge noticed in the morning, the country was still hilly but easily traversed.

July 1.—Following the road again, we ascended gradually for fifteen miles over broad plains, the pine and cedar forests receiving the addition of the majestic redwood. Many of these trees were five feet in diameter, and rising to the height of 125 and 140 feet. Before encamping, we descended for three miles by a steep, rough road, to a broad, grassy plain five miles in diameter, into which several small creeks were flowing, but we could nowhere discover a certain outlet. The hills and mountains, ten or fifteen hundred feet high, surrounding this plain, with open spaces between them, are heavily timbered, with the exception of one, which is so covered with stones that no space is left for trees. Several graves near camp marked the resting-place of unfortunate emigrants. Day's march, 18.84 miles.

July 2.—We passed out by the south side of the plain to a succeeding one of less size. It was here, as before, impossible to determine which way the water flows, if, indeed, it flows at all from these plains. We have crossed them in every direction, and as yet have not seen an outlet from one of them, and some of them we have been entirely around. From the second we passed to a third of these plains, of the size of the first, in which Pine creek, a fine little stream, flows towards its northeastern part, forming a marshy pond, which can only have an outlet to Eagle lake, if at all. In this plain we also came upon a wagon-road which had been recently used, and which we subsequently learned was the Noble's Pass road, which descends to the east by the same line we were about to explore. We followed it, therefore, and leaving the plain without ascending more than a few feet, continued our course through a dense forest of pine and redwood, passing several grassy ponds, the largest of which we judged to be a mile in length. Many of the largest trees were eight feet in diameter and of great height. We descended a little before encamping, coming upon a small creek, to which emigrants have given the name of Summit, although there are points in the pass several hundred feet higher than this. In approaching camp through the woods, the road was very much obstructed by surface stones, which would have been avoided by following an open, level, grassy space leading directly from Pine to Summit creeks, a mile north of the general line of the road, which enters it, however, at our camp. It was 10.57 miles from our morning camp to Pine creek, and 9.61 thence to Summit creek.

July 3.—The nights are cold in the mountains, but during the day the sun is hot, making the shade agreeable. Our path continued to-day through the same dense forest so oftened mentioned. In leaving camp we began almost immediately to descend, and continued to do so until encamping at the eastern base of the Sierra Nevada, after a march of 19.71 miles, in

Honey Lake valley, which extends forty miles to the east. The descending road was very stony, but we nowhere saw ledges or steep escarpments of rocks, until just as we were descending to encamp, when we passed over heaps of stones forming the edge or termination of a rising plain, upon which the higher masses and peaks of the mountain are elevated. This wall is vertical in many parts, to the height of thirty feet, but broken and fallen at others. The small stream known as Susan river follows the course of a low depression seen a short distance to the south of our path throughout the day. It breaks through the rocky wall described in a broken cañon, and flows gently through the valley to Honey lake, receiving two or three small tributaries in its course. Soon after leaving our morning camp, the road led over a high rocky butte, (which it could more easily pass around,) from which we had a fine view of the lake, a few miles to the northeast. It is several miles in extent, and is set beautifully blue in the mountains, which rise from 500 to 1,000 feet above it, covered with majestic pines. It has no outlet. We gave it the name of Eagle lake. From the foot of the butte a fine spring issues and sends out a creek towards Susan river.

As we entered Honey Lake valley, we found two brothers by the name of Roop, busily engaged in erecting a log-house and planting a small field. They had been here but a month. The lands around them at the head of the valley are very susceptible of cultivation, and are luxuriantly covered with grass and abundantly supplied with water by Susan river and other small streams.

Continuing our journey still to the eastward, we encamped on the evening of the 4th of July, after a march of 23 miles, on the shore of Honey lake.

CHAPTER V.

From the valley of Mud lake, via Honey lake and Noble's Pass, to Fort Reading, at the junction of Cow creek with the Sacramento river, California—July 5 *to* 12, 1854.

From Mud to Honey and Pyramid lakes.—Honey Lake valley.—Noble's road.—Boiling springs.—Northern limit of the sources of Feather river.—Reascending the Sierra Nevada *via* Susan river.—Plain from Summit to Pine creeks.—Character of the mountain from Susan river to Pine creek.—Grades.—Broad trunk of the mountain —From Pine creek to Black Butte creek. Grades.—Country directly west from camp on Black Butte creek; its impracticability for roads.—Ascending Black Butte creek.—Lava field —Black Butte.—Distribution of sand.—Grades.—Hat creek.—Head of Canoe Creek valley.—Line west from Hat creek.—Crossing Wolf creek to the western summit of the Sierra Nevada.—Grades.—Western descent of the Sierra.—Battle creek.—Deer flats.—Hill's rancho.—McCumber's mill.—Shingletown.—Narrow ridge and steep descent.—Table of grades and altitudes.—Difficulties of the pass for a railroad.—Arrival at Fort Reading.

July 5.—Messrs. Egloffstein and Snyder, escorted by Lieut. Baker and a detachment of riflemen, continued the exploration eastward to-day, to connect the survey from our camp of last night with the line previously explored to the entrance of Smoky creek in the valley of Mud lake. From a mile east of camp, Honey lake trends to the southeast for ten miles, to its most eastern point, and four miles from camp the party came to the foot of a spur setting down from the northern chain of mountains, affording them a view of the country eastward. From the vicinity of this spur in the open valley of the lake, there is, extending for several miles, an old shore-line raised a few feet above the present level of the lake, but to which it occasionally rises, perhaps, at stages of high water. To the eastward of this line the valley of Honey lake extends for 14 miles, and is generally of a dry, barren character. During rains and at the season of melting snows, small sheets of water stand at short intervals here and there upon it, and at present one is seen near the lowest passage to Pyramid lake. Beyond this plain, and forming its northeastern boundary, separating it from Mud lake, is a low mountain range, varying in height from 300 to 800 feet, with a general breadth of about nine miles. In this range several indications of favorable passages exist; but upon examination they proved to be worthless, and the party proceeded southward towards the main passage around this spur to Mud lake, at a point where Pyramid lake is also separated but slightly from the former, the three being united at very high stages of water, by a small stream flowing into Pyramid lake. This passage is open and level, and in its narrowest part about a mile in width; and from the valley of Honey lake to that of Mud lake, from eight to nine miles in length, the passage to Pyramid lake branching to the south from it. From the position from which it was seen, the passage to Pyramid lake appears to cut through an elevated rocky range, with high peaks rising on either side above the vertical cañon walls. There was a line of green verdure in the cañon, but no indications could be seen of a permanent stream flowing through it. Three small islands in Pyramid lake stand opposite the mouth of the cañon, with Pyramid island in the distance. The water of this lake is remarkable for its deep-blue color, and contrasts strikingly with its yellow rocky islands.

From our camp of June 14, on the west side of Mud lake, our present camp is approached by travelling south, and crossing Smoky creek four miles below its gorge, at the entrance of the Madelin Pass, and thence continuing to the southwest end of Mud lake, and following the open passage, already described, to Honey Lake valley, and thence by the north shore of that lake by a direct line. In the accompanying profile of this pass of the Sierra Nevada, which is known as Noble's Pass, the line just indicated is followed. For three miles from the first

point the descent is 13 feet to the mile; then ascends 3.60 feet to the mile for 42 miles, and 7.20 feet to the mile for the next 7.50 miles; with a descending grade thence to our present camp on Honey Lake shore, 8.50 miles, of 22.40 feet per mile—where our altitude is 4,094 feet above the sea.

In returning from their successful trip, Lieut. Baker and party halted a short time at warm springs, sixteen miles from camp; and at 10 o'clock at night, after a ride of 44 miles, encamped at a small spring of cold water, around which they found a little scattered grass. At 4 o'clock on the following morning they resumed their journey, and arrived at camp at 8 a. m.

Honey Lake valley is forty miles in length, east and west, and twenty in width. The extent of the lake itself we could not well determine, from its low shores; but it is about fifteen miles long, by eight or ten broad. It is shallow, and surrounded by low, marshy meadows, and extensive fields of tulare flags; but, outside of these marshes, the plain is firm and the travelling excellent. Its water has a disagreeable, alkaline taste. Towards the head of the valley a bold ridge rises from the plain, and extends back to a high, timbered range, rising 3,000 feet above the lake, and entirely enclosing the valley on the south. Its altitude, for many miles, is very uniform, not having a conspicuous peak upon it, nor a single break for a water-course. A few banks of snow still remain upon its summit. It extends to the east, falling off gradually to the cañon leading to Pyramid lake, and to the west of the summit of the Sierra Nevada, forming the southern chain overlooking the broad depression of Noble's Pass. To the north of Honey lake the mountains are broken, and destitute of timber; and, although connected in the eastern part, by ridges or spurs, with the Sierra Nevada, there are large depressions behind them; and the Noble's Pass road, which ascends Smoky creek for a short distance above Mud lake, passes behind them for a few miles to obtain water and grass, entering this valley over a low, broad ridge, near our camp. But the valley on the north side, towards the west, is enclosed by the main trunk of the Sierra Nevada, which rises into high peaks on the prolongation of the northern line of the valley, leaving a gradually ascending and very broad depression at its head—the line of the pass for many miles—with a few peaks rising above the general elevation, and the high, snowy peak of Mount Saint Joseph standing a conspicuous landmark on the western line of the Sierra Nevada, and overlooking the valley of the Sacramento.

Near our present camp there are fine boiling springs, in one of which a column of water, twenty inches in diameter, boils up a foot or more, at a temperature of 205° Fahrenheit; and, in the large stream which flows from it, the temperature is 170° fifty yards from the spring. Besides this, there are numerous hot springs, varying in temperature from 170° to 190°, from which gas escapes freely with the water. The rocks in the springs have a dark, volcanic character, but the surrounding masses are gray.

We had now examined every favorable indication for a pass which we could discover on the eastern slope of the Sierra Nevada in the vicinity of Mud lake; and I determined to turn my course westward again, and extend my examination of this pass to the valley of the Sacramento. It was supposed before commencing this survey, that any pass in this vicinity, leading to the summit of the Sierra Nevada, would necessarily bring us upon the waters of Feather river; but, in our several passages across these mountains, it was conclusively established that no water does, or can, enter that stream from north of the fortieth degree of north latitude, and that no pass north of Pyramid lake approaches it.

July 6.—Turning westward, we followed the valley of Honey lake, which was swarming with ducks and pelicans, and crossed Willow creek after travelling 11.36 miles—our barometers indicating, in this distance, a change of level of but fourteen feet—with an ascending grade of 11.70 feet per mile, for 8.64 miles, thence to the foot of the pass at Roop's farm, where we encamped, after a short march, on the seventh of July.

July 8.—In reascending the Sierra Nevada to-day, I followed the course of Susan river,

which descends in a broken, rocky ravine; and in its lower portion its walls frequently become vertical for considerable distances, partaking exclusively of the cañon character. Seven miles above the valley it is entered by a large ravine from the southeast, but it still preserves its general course, and eventually runs out. It is frequently broken throughout its entire length by small side ravines, and is generally narrow at the bottom and broad at the top; but, for short distances, it is alternately broad and narrow at the top and bottom. For the first three or four miles above the valley, the ravine is from two hundred to two hundred and fifty feet deep, but above that it seldom exceeds forty feet, except where small ridges, or spurs, approach it, when its walls become much higher, but are less vertical. After ascending it for eight miles, we crossed it, and ascended an elevated peak near it. The position of this peak was favorable for observation; but we could nowhere discover a route superior, or at all equal, to the one we were following, for a railroad to ascend this pass. Continuing our examination, therefore, we ascended the stream for four miles on its southern bank, to where it again receives a considerable branch from the southwest, and two small ones from the opposite side. But it was here rapidly running out; and a short distance above, the main stream descends in a channel but slightly depressed below the surface of the broad mountain plain which we were approaching. Passing again to the north side of the stream, we ascended it a short distance, and then crossed over and encamped with the main party, which had followed the road, on Summit creek, at our former camp of July 2.

July 9.—In leaving camp this morning, I followed the open, grassy plain, lying between Summit and Pine creeks, while Mr. Egloffstein proceeded with a party down the former stream until it disappeared in the plain; and then crossed over, without any material change of level, to the head of Susan river; and thence continued our line of yesterday, from Susan river by the ascending plain to Pine creek. This portion of the mountain is unobstructed by any sudden rise or fall, and can be traversed for several miles in any desired direction without obstruction. It will require a minute survey of the lower portion of this pass, to determine the best line by which to effect its ascent by a railroad; whether by ascending the ravine of the river, by which the grade is comparatively small, or by rising as soon as possible to the top of the ravine, with a heavier grade, thereby avoiding, to a considerable extent, the expensive labor of removing rocks for its passage. It is believed to be practicable to accomplish either. The ascending grades by the river, from Roop's farm, are, for the first four miles, an average of 10.10 feet to the mile; and for the next four miles, 105.50 feet to the mile; then 59.10 feet to the mile for 4.50 miles; and for the next 7.25 miles, after leaving Susan river, 75.10 feet to the mile; followed by 31.10 feet to the mile for 7.25 miles, and 54.30 feet per mile for 2.25 miles; with a descending grade of 27.70 feet per mile for five miles, to the west side of Pine creek. From Pine creek we passed through the open pine woods, and, bearing to the left, followed a grassy plain, gradually descending for 4.73 miles, with a high ridge on our left, which we continued to pass around, changing our course more to the south as we progressed. This prairie was from one to three miles wide, and was marshy in the southwestern part, where it terminates. Leaving it, we again entered a heavily timbered district, descending considerably for 3.75 miles, when we came again into an open prairie, and encamped on Black Butte creek—a small stream, three feet wide, flowing a little to the west of north, and eventually disappearing in the plain. The characteristic feature of the country traversed to-day is the broad trunk of the mountain—the plains which we are following—surmounted by elevated peaks and ridges, having no uniform direction, and with elevations varying from five hundred to three thousand feet above the plains, with drifts of snow only upon the most elevated peaks. From west of Pine creek to this camp the average natural grades, given by our barometers, are, for the first 2.89 miles, a descent of 63.20 feet to the mile; and 19.50 feet per mile for the following 1.84 miles; and 71.90 feet per mile for the next 1.70 miles; and 64.90 feet per mile for 2.05 miles; and 113 feet per mile for 1.55 miles thence to camp, where our altitude is 5,084 feet above the sea.

July 10.—From our last camp the road ascends Black Butte creek, which, for several miles, descends a broad valley, enclosed by high, rolling mountains to the northwest, and a more abrupt, but less elevated ridge, to the southeast. But to the west of that camp, passing north of the first-mentioned mountains, the view is unobstructed, except by timber. I therefore divided my party, examining the more southern route by the creek myself, and directing Mr. Egloffstein to pursue a general western course, by the most favorable route he could discover, to the most western ridge of the mountains. He proceeded through the dense pine forest, gradually ascending, but without obstruction, for five miles, but immediately afterwards came upon a precipitous rocky descent, increasing in height to the south, where it unites with the elevated mountain in that direction, and extending to the north far into the valley of the Sacramento towards Fall river, and nowhere presenting a practicable point for the descent of a wagon-road even, and much less of a railroad; and it was only after the most persevering efforts, and repeated failures, that he succeeded in effecting the descent with his party—descending 967 feet at an angle of nearly forty-five degrees, into the large, rocky valley of Canoe creek. This valley extends north to the Sacramento, and in some parts is several miles broad, but in others narrow; and is occupied, at intervals, by extensive beds of volcanic rocks, with intervening grassy spaces and pine forests, in which game is very abundant. Two considerable creeks enter it at its head, from the vicinity of Mount Saint Joseph, and unite to form Canoe creek; but it is probable that this stream sinks and reappears several times in its rocky course before reaching the Sacramento. For three miles up Black Butte creek our route followed immediately upon the banks of the stream, and thence followed the open, rolling pine woods, for 5.90 miles, to where the creek descends from high hills to the south. For several miles of this ascent the ground was covered with black, cindery sand, thin at first, but becoming very heavy as we progressed.

After leaving the creek we passed two or three small ponds, and entered one of the most recently formed and strongly marked volcanic fields we have seen in these mountains. It occupies a valley of three or four miles in length, by one or one and a half in width. The lava rocks are black, and about 100 feet high, occupying the valley in a confused mass, which it would be difficult to cross on foot. On the north side of this field stands the Black Butte, some 800 or 1,000 feet high. It is conical from its base upwards for several hundred feet, and is terminated in a peak with a semi-spherical outline; and its whole surface, as black as the darkest iron ore, is covered with a coarse, pebbly sand, formed from its crumbling mass, which has so smoothed its surface that a pebble would roll from its summit uninterruptedly to its base. The sand over which we approached this butte is uniformly distributed around it, as from a central crater, becoming thin towards the edges, and then disappearing. The width of the valley of Black Butte creek, and the broad, ascending base of the range enclosing it to the northwest, are such, that, in the construction of a railway, they will admit of a uniform grade, which will necessarily be heavy until passing the Black Butte, or for twelve miles. The road should ascend by the line indicated, for nine miles, to the small ponds at the foot of the lava-field; and thence be continued to the south and west, passing around it, and, returning northward, pass a short distance to the west of Black Butte. This line will increase the distance and improve the grade given in the profile. The distance from our morning camp to this point, by the road, is 11.69 miles, and the average grade 101.80 feet to the mile; and the greatest distance which could be gained, would not probably diminish it below 80 feet to the mile. From the point thus gained, in a broad depression, west for 1.87 miles, the descent is 25.10 feet per mile; and 19 feet per mile thence for 1.53 miles to the west, to a small spring; with an ascent of 5.80 feet per mile for 3.75 miles, to where the road should cross Hat creek. This point is reached by following the present emigrant road, west of the little springs just mentioned, until it reaches the head of Canoe Creek valley, where, instead of descending into that valley, following the wagon road, a railroad can only be continued to the west by bearing a little to the south and ascending the stream, to which there is no obstruction, for a mile, and crossing it at

the point already designated, where the valley of the stream is on a level with the approach to it. Immediately west of this creek a spur from Mount Saint Joseph—which stands but a few miles to the south of this pass—extends a short distance into Canoe Creek valley; and is followed to the west by the narrow valley of Wolf creek, immediately beyond which the most western ridge of the Sierra Nevada rises. The spur between the streams is heavily timbered, but more or less rocky, and falls off rapidly to the north, affording the means of passing it by almost any desired line. It is, however, more or less broken by small ravines of an ordinary character. The valley, or ravine, of Wolf creek is narrow and deep, but can be readily passed by ascending its eastern side nearly to its head, and crossing a deep, dry ravine on the spur, and following it until reaching the creek, whence the road should be carried immediately along the side of the rocky, timbered ridge to the west, to the western crest of the Sierra Nevada. The average grades by this line from Hat creek, are, for 2.75 miles, 45.10 feet per mile; and 154.4 feet per mile for 0.50 mile; and 21.30 feet per mile for 1.50 miles, to Wolf creek; with an ascending grade of 45.50 feet per mile for two miles thence to the western summit of the pass. The side of the mountain, from Wolf creek to this summit, is broken by two or three large ravines, and, besides being covered with surface-rocks, large ledges crop out at various points upon it. The summit depression of the pass itself is three-fourths of a mile broad towards the east, and very soon expands to two miles—a high, round peak, destitute of timber, rising to the north to the height of 300 feet; and, to the south and east, steep, rocky peaks and masses rise towards Mount Saint Joseph, (sometimes called Lassen's Peak,) which is three or four miles distant, and covered with snow from its summit downwards for a thousand feet. We encamped on Wolf creek, two miles east of the summit. Day's march, 20.34 miles.

July 11.—We returned to the summit of the pass, which is covered with immense heaps of broken stones, covering miles of surface, like rubbish from a quarry, but so level that water stands upon it in various places for half a mile, and it is lightly timbered. Its approximate altitude is 6,074 feet above the sea. The descent from it to the valley of the Sacramento is unobstructed, and, unfortunately, very direct. For five miles from the summit about half of the descending plain or broad ridge is timbered, and the open portion covered with a dense thicket of mansanita bushes. Unfortunately for us, on both occasions on which we passed this summit, (we repassed here on the 25th of July,) the view of the mountains for any considerable distance below us was obscured by a smoky atmosphere, and the valley of the Sacramento entirely invisible from the dark cloud of smoke which hung over it, over which, however, as over a blue sea, peaks of the Coast range were occasionally visible. The plain of descent widened rapidly at first, as we descended, and four miles from the summit we judged it to be four miles in width, limited on the south by the deep ravine of Battle creek, (descending from Mount Saint Joseph,) which, however, soon runs out into the general level of the descent, and broken on the north by a formidable dry ravine commencing near the foot of the rubbish heaps at the summit, and extending several miles, and numerously intersected by ordinary ravines. Coming upon Battle creek, the road descends it for a short distance, and crosses it where it bends to the northwest, the road continuing its direct course, and entering a dense forest of pine, cedar and redwood. The mountain continued to fall off rapidly, and we made short, steep descents for a few hundred yards at a time, as from successive terraces. But after crossing the creek there is a deep ravine seen 3.50 miles to the southwest of the road, and nearly parallel with it, marking the southern slopes of the level intervening space between Battle creek and one of its tributaries, which descends from the south side of Mount Saint Joseph. This space is embraced in the general plain of descent, and considerably increases its width, affording the means, by its uniform character, for continuing the curves of a railway in any desired direction to the south of Deer Flat, nine miles from the summit, where a small farm is established on a few acres of open prairie, and thence to Hill's rancho, 3.69 miles below, on Battle creek, where the descent for much of the distance is imperceptible. Crossing the creek, we continued on through the same dense forest, interspersed with large branching oaks, across the most favorable

and perfectly practicable section of the pass, and encamped near McCumber's mill, 8.72 miles below.

In the early part of the day the road was very much obstructed by loose stones, but for the last fifteen miles it was very fine. Many of the pines were from four to six feet in diameter, and from one hundred to one hundred and fifty feet high. Several mills are in successful operation in the vicinity, and others are being built. Day's march, 23 miles.

July 12.—For two and a quarter miles this morning—passing through Shingletown—the descent was scarcely perceptible; but the country there becomes more broken, and formidable hollows and ravines extend from the road north to Bear creek—which before lay considerably to the north of the line of descent—rendering the winding of a road in that direction quite impossible. The country also became more broken to the south, towards Battle creek, leaving comparatively a narrow ridge upon which to effect a descent to the foot of the mountains. The distance between the streams themselves is about 4.25 miles at this point, and is not only broken by the large hollows referred to, but the remaining portion of it, 1.25 miles wide, the most favorable line and greatest width which we could discover for the construction of a railway on this part of the descent, falls off rapidly and is very broken, and intersected by broad and deep ravines, especially outside of the narrow ridge followed by the present wagon road. This narrow ridge continues for four miles, but the descent is still rapid for seven miles further, and the country broken into narrow ridges descending to the west, yet there is much greater room for increasing the distance and overcoming the descent. The country is here no longer a forest, but a broken and open oak prairie, dry and parched at this season of the year, but very soft and miry during the rainy season. Forty miles below the summit we were passing the lowest foot-hills of the mountains, and were fairly in the open valley of the Sacramento river. The heat increased with our descent, the thermometer standing, in the shade at 3 o'clock p. m., at 106° Fahrenheit. We continued on, however, and encamped, after a march of 23.72 miles, at Fort Reading, on the west side of Cow creek, a mile and a half above its junction with the Sacramento.

Table of approximate average grades, in descending by a very direct line from the western summit of Noble's Pass of the Sierra Nevada to the Sacramento river.

Stations.	Intermediate distances.	Total distances.	Average descent per mile in feet.	Altitudes above the sea in feet.	Remarks.
Summit				6,074	
Battle creek	5.00	5.00	49.80	5,825	
	2.50	7.50	212.60		
	2.12	9.62	284.00		
Deer Flat	2.14	11.76	174.50	4,318	
	1.69	13.45	101.70		
Hill's rancho	2.00	15.45	7.35	4,131	
	4.14	19.59	47.60		
	3.58	23.17	136.60		
McCumber's mill	1.00	24.17	54.60	3,491	Camp.
	2.38	26.55	2.80		
	3.05	29.60	230.10		
	2.19	31.79	235.50		
	3.78	35.57	186.20		
	2.93	38.50	166.90		
	2.54	40.04	78.80		
	4.37	45.41	41.40		
Fort Reading	2.25	47.66	14.10	674	
					Total descent 5,400 feet.

In the preceding table and the profile of Noble's Pass, accompanying this report, for the first five miles from the summit I have given the longest line of descent which can be obtained (the

direct line being but three miles) by winding from the summit of the pass south along the foot of the nearest peaks, and touching Battle creek. Below this, the distances and line of profile are those of the direct line of descent; for the total descent, 5,400 feet—5,000 being confined to the first forty miles of the direct line—is so much more unequally distributed than was anticipated when making the survey, that, at two points it is not practicable, without a minute survey and actual location of the road, to indicate a continuous line upon which a railway can be successfully constructed to descend this pass; and I have, therefore, not deviated from the direct line. But it can only be carried below the point indicated on Battle creek by continuing the curve and crossing to the north the deep ravine before referred to, and again re-crossing it on a curve to the south, returning to and across Battle creek, and thence, by a continued series of similar curves, effecting the descent. The width of the descending ridge is so great, and its general character such, however, as to establish the strongest probability of the practicability of effecting the descent on large and practicable curves to Hill's rancho; and there is no difficulty in continuing it thence to McCumber's mill—24 miles (including the curve for the first five miles) from the summit. From this point the road should follow, for some distance, a branch of Battle creek to the south, relieving, as far as practicable, the difficult section below Shingletown; for the broken narrow ridge by which the descent must be continued for four miles below this point is such, and the descent so great, as to render it doubtful whether it can be successfully descended without stationary power. A further survey and actual location of the road, as before indicated, is, however, necessary to determine this point. And if the general character and location of the route connecting with this pass is such as to render the determination of this point desirable, the resurvey should be continued to the summit of the pass.

The section immediately succeeding the one just indicated is that of the foot-hills of the mountains; and is rough, descending in narrow ridges, but a railway can readily be carried over it.

We were courteously received at Fort Reading by the commanding officer, Colonel Wright, and the other officers of the post, and hospitably entertained by them during the two days which we were detained in getting our animals shod and procuring necessary supplies for our trip up the Sacramento to the mouth of Fall river, to complete the line of exploration by the Madelin Pass.

CHAPTER VI.

Ascent of the Sacramento river from Fort Reading to the mouth of Fall river, (line of the Madelin Pass,) and thence by the valley of Canoe creek to Noble's Pass, and return to Fort Reading—July 15 *to* 26, 1854.

Character of the Sacramento valley above Fort Reading.—Mining village.—Sacramento river enclosed by mountains; its character.—Trail to Yreka.—Stream known as the Sacramento.—McCloud's Fork.—Salmon.—Pittsburg ferries.—Snows and freshets.—Ascent of the river.—Rapids.—Hot spring.—Re-ascent of mountain.—River still shut in by precipitous mountains.—Valley at the mouth of Canoe creek.—Second cañon of the Sacramento; its character.—Table of grades from Fall river to Fort Reading.—Completion of the survey of Madelin Pass.—Return to Black Butte creek, Noble's Pass.—Numbers of Indians daily seen.—Fields of lava.—Valley of Canoe creek; difficulty of its passage.—Disappointed in the course of Black Butte creek.—Night march.—Return to Fort Reading.—Sacramento valley.—Party disbanded.

July 15.—Leaving Fort Reading, we ascended the valley of the Sacramento, by a general course a little west of north, passing over a hilly country of open oak prairie for sixteen miles, and encamped without reaching the river, which is a few miles to the west of our path. For several miles above the Fort the valley of the river is an open, rolling prairie, more or less timbered with oak and a small growth of pine. The general level of the country is, however, elevated above the immediate plain of the river banks, and is broken by dry ravines and hills, which continue to rise as they recede from the stream, and are eventually united to the great mountain masses which entirely enclose the head of the valley, and shut in the river from immediately west of our present camp upwards to the mouth of Fall river.

July 16.—Five miles from camp, this morning, we came to a small mining village called Churntown. It consists merely of a dozen miserable log-huts, and being badly supplied with water at this season of the year, is in a thriftless condition. The day, too, was intensely hot, and the men had everywhere thrown by their tools—not a man being seen at work. It was four miles from this village to the Sacramento river, directly north, and its mountainous position cannot better be illustrated, perhaps, than by the fact, that the stream or rivulet which supplies Churntown with water rises but a mile from the river, but instead of flowing north towards it, it descends in the opposite direction, and enters it below our last night's camp. From the head of this creek we descended by a very steep Indian trail directly to the river, where it is two hundred feet wide, flowing with a very rapid, powerful current, and, with the exception of short distances here and there, breaking over a rocky bed. In seasons of high water it sends down immense volumes, the drift being ten and fifteen feet above the present stream. The mountains rise abruptly from the river banks to the height of eight and ten hundred feet. They are timbered with pine and oak near the river, but rocky ledges slope down to the water's edge; and it is, at intervals, impossible to ride along the Indian trails which lead over the water-washed drifts and heaps of rocks lying on the banks. At points where rocky strata crop out on the river banks, the Indians themselves are forced more or less to ascend the side of the mountain in travelling up and down the river, and in many instances, to avoid long bends of the stream, pass over the projecting spurs. In its mountain course the river is winding; but in its general direction in this part, it descends from a little east of north, and continues it a short distance below our present position, when it changes more to the south and eventually a little to the east, as it enters the open valley below. We began its ascent by riding, when we could, on the trails, but were frequently forced to leave them and pass over spurs, up which our animals could not carry us, and we suffered greatly from the intense heat of the day.

The river is followed on the opposite bank by a heavy pack-trail leading to Yreka; but it soon leaves the main river, and follows the course of an affluent from the north, which has been generally mistaken for the Sacramento itself. It is, however, but a small stream compared with the main river, to which the name of Pitt has been given. Six miles above the mouth of this stream we came to the mouth of McCloud's fork, a larger stream than the former, also entering the Sacramento from the north. Salmon abound in this stream, and in the Sacramento, but far more abundantly below this junction than above it. The stream was lined with Indians, many of whom were entirely naked, while others were provided with a single garment, or had their faces blackened with tar in mourning for their friends—the tribe having been recently severely punished by the neighboring miners and settlers, whose friends had been killed by them. From McCloud's fork, two of them accompanied us to our evening camp, 5.25 miles above, which we reached at dark, drenched with perspiration, our animals trembling with heat and fatigue. At this point there is, on the south side of the river, a small grassy prairie a few hundred yards wide, and a ferry is established by a Mr. Dribblesby for the use of a mining town, three miles to the north, called Pittsburg. The river, for a mile opposite this prairie, flows with a gentle, unbroken current; but at its foot makes a short bend, and desends rapidly over its rocky bed. I purchased from one of the Indian women, to-day, a girdle of the size of an ordinary rope, made entirely of human hair. Day's march, 24 miles.

July 17.—We rode on the bank of the river, this morning, for two miles to Silverthorn's ferry, and were then driven high up the mountain to avoid deep ravines, and to pass around ledges and masses of fallen rocks found at a few points—the mountains dividing the valley of Cow creek, which we occasionally overlooked at a distance, from the river immediately below us. The character of the river was the same to-day as yesterday, curving among the high hills and mountains. The timber of the forests was also the same, and the character of the hard, dark, trachytic rocks unchanged. Indian smokes curled upwards from every part of the mountains where they were engaged in burning the grass to catch grasshoppers, upon which they feed, regarding them as a great delicacy. We encamped on a small flat, 200 yards wide and a mile long, on the river bank, 10.50 miles above our morning camp. From the most reliable information we could gain from persons who have lived on the river for two or three years past, the amount of snow which falls upon the higher parts of the mountains is large; but upon the river itself it is small, never exceeding four or five inches in depth. They also state, that upon the river banks, which are completely sheltered from the winds, it never accumulates in drifts, being deposited on the sheltered sides of the mountains long before reaching the stream. They state, also, that the river is never choked up with ice, but that it rises ten feet above its general level in times of great freshets.

July 18.—Clambering along the mountain sides, we again returned to the river 4.70 miles above our morning camp; and in passing a rocky point several mules were crowded into it, and swam with their packs to the opposite bank. And in addition to previous difficulties encountered in following the river banks, it was obstructed by dense thickets of bushes and fallen trees lying at right angles to our path. But to ascend the mountain sides, and pass along where we could observe the character of the river, was also very difficult, and several of our animals repeatedly lost their footing and rolled back hundreds of feet, in passing the steepest points. We were constantly in positions to overlook the river, but did not again descend to it during the day, its character remaining entirely the same. The mountains, however, became higher, and the ravines longer. We encamped, after a march of but 11 miles, at the head of a ravine, where we found a small spring and a little grass in the open pine and oak forest.

July 19.—We returned again to the edge of the mountains overlooking the river, and at 9 o'clock a. m. again descended to it, hoping to be able to follow it; but we here found it more confined by rocky ledges than in any other part of its course, the ledges being, at some points, quite vertical on alternate sides of the river. The ravines, too, were more rocky and precipitous than before, and we were forced, after examining it, to retrace our steps for nearly a mile, when

we again turned up the river, and crossed two or three small streams, gaining a position from which we overlooked it for several miles, both above and below, but we could discover no improvement in its character: our course, however, changed to nearly due north, parallel with the river, and but a short distance from it. The summit of the mountain was broad and level, and the timber unusually heavy, and a fine growth of raspberries reminded us of our boyish days. At the end of this direct course, we again descended to the river, and found it a foaming rapid for several miles above its change of course. Its fall here is twice as great as in its general descent. Just above its change of course there is a small boiling spring, the stream from which immediately falls into the river. Above this spring there is a rocky valley, half a mile wide, timbered with oak, in which we encamped after a march of 23.50 miles. The mountains passed to-day were more elevated than those crossed yesterday, but were not so difficult to traverse.

July 20.—We followed the rough bank of the river, this morning, for 7.50 miles. On the side of the trail there was something like a valley, uneven and rocky, but it soon became rough and broken; and the mountains, eventually shutting in close to the stream, were too steep, and too much obstructed by fallen timber and dense thickets of bushes, to admit of further progress along its shores. The opposite bank was, at the same time, more than usually steep and rocky, and at some points almost vertical. There was no alternative, therefore, for us but to re-ascend the mountains; for, with our force, we could not have progressed three miles a day by cutting a road along the mountain base. The ascent was very steep and difficult, and we were occupied four hours and a half in effecting it. And when we had gained the summit, which we followed for some miles high above the stream, which could be traced by its foaming current, not only where we were passing to-day, but at the foot of the long line of the heavily timbered summit followed yesterday, we encountered such a dense growth of mansanita and laurel bushes that it was only by the most persevering efforts that we could effect a passage through them. Steep ravines extend from the river quite to the summit of the mountains, and we were always forced to pass around them. Coming eventually, however, to an open woods, we pushed rapidly forward, and at sundown came upon an open, grassy prairie, abundantly supplied with water. This was the first grass we had seen during the day's march of 18.50 miles, and was a most welcome sight.

July 21.—We passed directly over the crest of the mountains towards the river, to points where we could overlook it immediately at our feet. For several miles below us its banks were as high and rocky as at any point below; but immediately in front of us, and for a short distance above, with one exception, the projecting ridges or angles were low, and for short distances one could ride comfortably along the base of the mountains. The river was, however, still shut in by mountains, and its current was as rapid as ever. But the mountains were so broken by ravines that we could not pass along them, and were obliged to recross the summit, where we at once came upon a more level country, but very rocky and dry. The mountains on the river also began immediately to fall off, and we easily returned to it a short distance below the mouth of Canoe creek, where there is a small valley extending for five miles along the river. This valley is a mile wide only, but the mountains above are low and retreating. Canoe creek is sixty feet wide at its mouth, with a current as rapid as that of the Sacramento. The Indians have large fish-traps arranged in it, but the salmon season has not yet arrived. Crossing the creek we ascended to the head of this valley, passing several holes dug by parties searching for gold; and at the head of the valley reached the foot of the cañon, before described as the second cañon of the Sacramento, immediately below the mouth of Fall river. The walls at the lower end are higher, but much less vertical than at the upper end of this cañon; and the accumulated mass of fallen rocks extends from the water nearly to the top. It is much wider also at the lower than at the upper end; and the peaks rising on the terrace above, sloping gently back, are less elevated. It is, however, a formidable cañon, cut deep through strata of trachytic rocks; and in descending the Sacramento with a railway, as before stated, it will be

a point, which can only be determined by a minute survey, whether it will be easier to pass around it to the south, over the lava fields at the foot of the ridge or butte which rises on that side of the cañon, and return to the river at the mouth of Canoe creek, than to descend by the cañon itself.

Table of approximate average grades in descending the Sacramento river, from the mouth of Fall river to the head of steamboat navigation at Fort Reading, California.

Stations.	Intermediate distances.	Total distances.	Average descent per mile in feet.	Altitude above the sea in feet.	Remarks.
Mouth of Fall river...	.....	.....	.....	3,249	Head of second cañon
Foot of second cañon.	8.95	8.95	35.00		
Mouth of Canoe creek.	4.70	13.65	14.00		
Sacramento river.....	22.50	36.15	30.70		
Sacramento rapids ...	7.50	43.65	59.60	1,730	
Sacramento river.....	26.50	70.15	21.70	1,156	
	4.70	74.85	16.60	1,078	
	10.50	85.30	11.80	954	
McCloud's Fork.....	5.25	90.55	6.10	922	
Sacramento river.....	11.75	102.30	7.20	837	
Fort Reading.....	22.90	125.20	7.10	674	

Having completed, by this connection, my exploration of the line of the Madelin Pass entirely through to the head of steamboat navigation on the Sacramento, we turned our course towards the south to explore the country drained by Canoe creek, and, if possible, discover a route connecting the Sacramento, at the mouth of that creek, with Noble's Pass at Black Butte creek, where the emigrant road first strikes it in crossing the mountains from the east, by which, if no better route could be found, the steep descent from that pass to the west would be avoided.

The ascent of this creek for the first mile led us over thorny bushes and rocky bluffs; and in their passage we were greatly aided by a heavy Indian trail, always serviceable when available, and here doubly acceptable, for our animals were both jaded and sore-footed from constantly travelling on the sharp angular fragments of rocks. For the first mile, also, the stream was full of foaming rapids at short intervals; but above that point we came to an open grassy prairie of small extent, through which the stream flows gently, and in its passage receives two or three respectable tributaries, one of which, from the southwest, falls with considerable noise into the main stream. We encamped under a wide branching pine in the centre of this prairie.

July 22.—Just above our morning camp we ascended a terrace wall, fifty or sixty feet high, to a nearly level plain, upon which we followed an Indian trail for two miles. This plain was covered in various parts with grassy ponds, but it was obstructed to the southeast and east by large fields and hills of volcanic rocks, with dark ledges and masses here and there, and it was apparently impassable. To the west there was an open pine woods and a low range of hills, apparently succeeded by another plain, upon which there is a lake called Freaner, the name of an unfortunate gentleman who is supposed to have been killed by the Indians in its vicinity. Many Indians were daily seen in every part of the mountains, but they invariably fled upon seeing us. Dismounting from our animals, we determined to attempt the passage of the field of lava (pedrigal) to a high bluff beyond; but the path was so bad that many of them could not be led, and we were obliged to remount, and in two miles succeeded in extricating ourselves from it by the most difficult path I have ever seen. Ascending the bluff, the red soil of which was friable and dusty, we still found a stony path, but it afforded us an extensive view of the country for many miles, overlooking the Sacramento and Fall rivers, and the valley of Canoe creek. Here, as above, the valley of Canoe creek is but a few miles wide, and is almost entirely occupied by fields of volcanic rocks—the part we had crossed being but a small angle

of it. The course of Hat creek, which enters it at its head, could nowhere be traced, and it is probable that it occasionally disappears among the open rocks of the valley, and again reappears when no longer finding a subterranean passage. Our course continued along the bluff, which is broken by deep ravines, and is the same that Mr. Egloffstein encountered in crossing to the west from Black Butte creek on the 10th instant, and by which we hoped to reach that stream, as it was supposed to be an affluent of Canoe creek, and it was near night when we reached the base of the mountains south and west of our former camp on that stream without finding it, or, indeed, any but the most trifling amounts of water in springy places; and as the country to the north, to the line we followed in our trip to the mouth of Fall river, was overlooked by us all day, and we could nowhere discover any indication of a stream, we came to the conclusion that, like most of the streams we have seen in these mountains, Black Butte creek sinks in some of the grassy plains before reaching the river. We were therefore obliged to turn eastward to find a suitable camp, and were soon overtaken by night in a dense forest, obstructed by a thick undergrowth, ledges of rocks, and fallen timber. But I determined, notwithstanding these difficulties, and that there was no trail—the stars being visible, however, through the pines—to proceed to our former camp on Black Butte creek. But as I could not see the ground, even when on foot, I owed my determination entirely to the confidence I had in my mule to conduct the party safely through. I gave her a loose rein, only occasionally bringing her back to the proper course when forced from it by insurmountable obstacles, and the men set up a merry song to enable them to follow each other; but it was not until 11 o'clock at night that we emerged safely from the forest at our former camp, after a most laborious ride of 35 miles upon which we were engaged for fifteen hours. We had failed, however, in finding a route by which to descend with a railroad from this point to the mouth of Canoe creek, having traversed a rough, broken country, and encountered abrupt descents, which we could discover no means of avoiding.

From this point we returned to Fort Reading, re-examining the most difficult parts of Noble's Pass to the west, the result of which is embraced in the report already given of that pass, where we arrived on the 26th of July, and were kindly received by our friends. Fort Reading is in latitude 40° 30′ 02″, and by the course of the river about 300 miles from the sea, but only 200 or 220 by the direct course of the valley, and, as indicated by our barometers, 674 feet above it. The valley of the Sacramento is here from ten to fifteen miles wide, but is more or less occupied by the foot-hills of the Sierra Nevada on the east, and of the Coast range on the west, and these hills occasionally extend in bluffs, of sixty and a hundred feet in height, quite to the river banks; but they become much less frequent as we descend, and eventually entirely disappear near the river, and the valley becomes wider, more open, and level. It is occupied in various parts, throughout its whole extent, by extensive farms and flourishing settlements, and is well known to be finely adapted to the construction of a railway.

Having thus connected my line of survey with this valley by the most practicable route, as required by your instructions, I at once disbanded my party, and reported to you in person, in this city, on the 12th of September.

CHAPTER VII.

General Summary and railroad practicability of the line explored on the forty-first parallel of north latitude.

Railroad connexion east from Fort Bridger.—Valley of Green river.—Grazing cattle in winter in the mountains.—Mormon settlement on Smith's Fork.—Bear River, Wahsatch, and Uinta mountains.—Highest point of the line reached.—Appearance of the country thence west.—Depth of snow.—Timber, soil, and grass.—Length of line from Smith's Fork to Oquirrh mountain.—Cañones of the Weber and Timpanogos rivers.—Railroad in the Jordan, Tuilla, and Lone Rock valleys.—Mormons desirous to aid in the construction of the road; their numbers.—Cedar mountain.—The Desert.—Passages to the south of Pilot Peak, and thence to the Humboldt mountains.—Humboldt Mountain Pass; its altitude.—Timber and its abundance.—Valley of the Humboldt river.—Country south of this valley; its profile.—From Humboldt river to the foot of the Sierra Nevada.—Fertility of this section —The ascent of Madelin Pass; its altitude; broad plain at its summit.—Highest point of the pass; its western descent; timber, and soil.—Round valley.—Sacramento river.—First cañon of the Sacramento.—Second cañon of the Sacramento.—The Sacramento below the mouth of Fall river.—Noble's Pass of the Sierra Nevada.—Mud lakes to Honey lake.—Honey Lake valley.—Ascent of the mountains.—Susan river.—Pine creek.—Black Butte creek.—Black Butte.—Hat and Wolf creeks.—Greatest altitude in this pass.—Descent from the western summit of the Sierra.—Depth of snow in the winter in this pass.—Dr. Wozencraft's observations.—Entire length of the pass.—Head of steamboat navigation of the Sacramento.—Future surveys.—Method of determining levels.—Building-stone upon the route.—Water.—Cultivable land.—Directness of this line; its length.

Having concluded the journal report of my explorations for the Pacific railroad, of what may, very properly, be designated the route of the forty-first parallel of north latitude, which is both central, as regards its geographical position and its connection with the general lines of commerce of all parts of our country, the general features of the route explored, and its adaptation to the particular object of its examination, will be succinctly presented.

This route is intended to connect, in the vicinity of Fort Bridger, in the valley of Green river, Utah, with that explored thence eastward by Bridger's Pass to the Plains, by Captain Stansbury, in returning from his survey of Great Salt lake, in 1850; and it is only necessary that I should refer you to his report of that part of the route for its clear understanding, and connections thence eastward with the general lines of commerce of the country, either by descending Lodge Pole creek, the South fork, and main Platte, to the Missouri, or by keeping to the east of Crow creek and passing over to the Republican fork of the Kansas, and descending the former stream to its junction with the latter, and thence pursuing any desired route to the Missouri.

That part of the valley of Green river in which Fort Bridger is situated, and which is overlooked from the foot of the Uinta mountains by the line which we followed in our explorations eastward from Bear river, constitutes a remarkable feature upon this line. It has been variously designated as the valley of Green river, the Green River Basin, and the Coal Basin of Green river, from being abundantly supplied with that important article. It is more than two hundred miles in extent from east to west, and has a variable width, north and south, from twenty to over a hundred miles. It is enclosed on the east by the Rocky mountains, and on the northeast by the Sweet Water and Wind River mountains—Green river entering it from the north—and on the northwest and west by the Bear River mountains; and on the south by the Uinta mountains, broken by the deep cañon by which Green river continues its course to the south. Its borders are occupied by spurs from the surrounding mountains, and a few detached buttes are seen east of Green river; but its general character is that of an elevated rolling plain or valley, easily traversed in any direction. It is drained by Green river, which passes southward through its centre, and by its tributaries. Its soil is light and dry, with a small

scattered growth of cedar upon the mountains, and borders of grass are found upon its water-courses; but artemisia, with a little scattered grass, occupies the valley in every direction, and characterizes its vegetation. The trading post at Fort Bridger has been occupied constantly for the last ten years; but the district was much frequented before by traders and trappers, whose effects are always transported by cattle, which subsist themselves throughout the year by grazing—a fact remarkably significant of the winter climate, and depth of snow which falls in the district, the general elevation of which may be safely taken at 7,000 feet above the sea. And it is said, by these people, to be a well-established fact, that horned cattle, of which their stock largely consists, cannot so subsist where the snow is deep enough to bury their eyes and enter their ears as they feed. I have already stated, in this report, that the Mormons have commenced a settlement near Fort Bridger, and that large herds of cattle were grazed near it during the early part of the winter, and were subsequently driven over the mountains, and remained in the valley of the Weber river until spring.

Two ranges of mountains, more or less united, intervene between this valley and that of Great Salt lake. The first, or more eastern, is the Bear River range, which is broken and surmounted by elevated peaks towards the north, but is more broad and open towards the south, where it unites with spurs of the Uinta and Wahsatch ranges. It is drained on the east by Black's fork and its tributaries, an affluent of Green river, and on the west by Bear river itself, which rises in the Uinta mountains and flows northward, breaking through the Wahsatch range and emptying into Great Salt lake.

The second, or western range, which stands immediately on the eastern border of the Basin, is the Wahsatch, extending from Little Salt lake, in a very direct line northward for 300 miles to Bear river. It is broken, towards the south, only by the passage of the Sevier river; but on our present line by the narrow passages of the Timpanogos and Weber rivers, by either of which, after crossing the first range, by ascending the divide between Black's fork and the Muddy, and crossing the heads of the latter stream and Bear river to the head of White Clay creek, (an affluent of the Weber) it is very practicable to descend to the valley of the Great Salt lake with a railroad. Looking westward, from the divide just indicated, the country presents a broad, level appearance, and it is difficult to realize its great elevation. It is, however, intersected by the valleys and ravines of the various water-courses by which it is drained, and which extend into the Porcupine terrace, lying at the northern foot of the Uinta mountains. The greatest elevation upon the line occurs upon this terrace, between the sources of Black's fork and the Muddy, and, as indicated by our barometers, is 8,373 feet above the sea. By ascending the Muddy, two hundred feet of this elevation would be avoided; but the line would require more and smaller curves. It is here, also, that the greatest depth of snow is encountered, and it increases in depth as we approach the snowy Uinta range. When we crossed it, in April, the streams were not swollen, and we could not discover that it had diminished by the warmth of the season from its usual winter depth. On the northeast slopes of the hills and ravines it had accumulated in deep drifts, but its general depth varied, for a few miles, from twelve to sixteen inches; and in crossing Bear river, and on the head of White Clay creek, it was from eight to twelve inches; but below this we encountered no snow. The timber of this section is limited in quantity, the ridges being dotted with a scattered growth of small cedar, and the Porcupine terrace dark with a respectable growth of spruce, pine, and fir. The soil of the mountains is superior, and covered with a luxuriant growth of grass. The distance from Smith's fork, on which we encamped, near Fort Bridger, by the line of the Timpanogos river, to the northern point of Oquirrh mountains, at the south end of the Great Salt lake, and on the western side of the valley of the Jordan, is 182.55 miles; and the same point would be reached by descending the Weber from the mouth of White Clay creek and following the eastern and southern shore of the lake, by a line of equal length. The respective average grades and altitudes upon these lines, and throughout the lines of the survey, will be found in the accompanying table and upon the profiles submitted with this report. There are large

cañones on both of these streams—one upon the Timpanogos, and two upon the Weber. The former is ten miles in length. It is from 100 to 300 yards wide, and very direct in its general course; but projecting masses or spurs on either side of the river overlap partially, giving it a slightly sinuous course at the bottom. The great mass of the rock of which it is formed is blue limestone, on the south side often nearly vertical, but more inclined and open and covered with small stones and a luxuriant growth of vegetation on the north side, along which we rode. It will be necessary, in passing it with a railway, to bridge the river at several points to avoid curves, and to blast the rocks to a considerable extent at some points, amounting, however, to no large aggregate. The river is thirty yards wide, descending with a powerful current. The upper cañon on the Weber deserves the name only of a gorge or defile. It is eight and a half miles in length. The passage is more broad and open, and not so direct as that of the cañon twelve miles below, on the border of the valley of Great Salt lake. The mountains rise to a great height above it, and are rocky and precipitous, and much broken by ravines. The river winds from side to side, frequently striking against the base of the mountains, and the path crosses it frequently; and in constructing a railroad it will be necessary to bridge it several times. But it can be built by cutting and filling at the base of the mountains with the same facility that roads are carried elsewhere at mountain bases, where the formidable name of cañon is not encountered. The lower cañon, which is four miles long, in some parts wel deserves the name. It is, however, very direct, with an average width of 175 yards, the stream being 30 yards wide, and frequently impinging with great force against the base of the mountains. At a single point only, near the head of the cañon, the river is narrowed to one half its usual width, 30 yards, and has cut a passage 20 or 30 feet deep through the solid rock, which on the north side, at this point, overhangs the stream, which is deflected from its course by a low projecting mass, for a few yards, but again immediately resumes it. The rocks are principally gneiss. The mountains are sufficiently retreating to admit of a practicable passage of the gorge by a railway, and it will require an amount of blasting no greater than is required in constructing a road on a rocky mountain side of similar extent elsewhere. Entering the valley of Great Salt lake from either this or the Timpanogos cañon, a railway meets with no obstruction in passing by the south end of the lake and crossing the Jordan, Tuilla valley, and Spring or Lone Rock valley, to its west side, the grades being merely nominal.

The settlement and cultivation of this valley by the twenty-seven thousand industrious people who inhabit it—the number at which the church authorities estimated their population when I was among them, and it did not seem to be an exaggeration—is so obviously a matter of great importance in connection with the construction of a continental railway, that only the simple statement of its being embraced in this line is necessary, and that its construction is an object which the Mormons are anxious to assist in accomplishing. From the western shore of Great Salt lake to the valley of Humboldt river, the country consists alternately of mountains, in more or less isolated ranges, and open, level plains, rising gradually from the level of the lake on the east to the base of the Humboldt mountains on the west, or from 4,200 feet to 6,000 feet above the sea. Cedar mountain lies immediately on the southwestern shore of the lake, and gradually subsides towards the north, terminating in Strong's Knob. But to pass entirely around it would unnecessarily increase the length of the line, for it can be crossed, not only by the line followed by Frémont in 1845, at an elevation of 800 feet above the lake, but apparently at a much lower elevation, a few miles north of this point. Immediately west of this range there occurs a desert plain of mud, about seventy miles in width from east to west, by its longest line, which becomes narrowed to forty, and eventually entirely disappears as it extends southward—less than thirty of which is miry by this line—and it is firm in proportion to the distance from the lake. Two or three small isolated rocky ranges stand in it, but it appears otherwise to the eye, as level as a sheet of water. To the west this desert is succeeded by broken mountain ranges, one of which is terminated towards the south near Pilot Peak, affording the means of reaching and passing to the succeeding plain. To the south of this passage, however, an equally

favorable passage exists to the north of Fish creek, connecting directly with passages to the west quite to the base of the Humboldt mountains; and this will doubtless be the preferable line, as it will enable us to cross the desert by a shorter line and a more firm path. The ascending grades upon this section will be merely those of the ascent of the successive plains. The Humboldt mountains are a narrow but elevated ridge, containing much snow during most of the year. The length of the pass by which they will be crossed is nine miles, about three of which are occupied by a narrow rocky ravine, above which the road should be carried on the sloping spurs of the mountains, on the western descent. The summit of the pass is five hundred feet above the extensive plain east of it, but considerably more above the valley of Humboldt river, which succeeds it to the west. This pass offers no serious obstacle to the passage of a railroad. Cedar only is found in these mountains, and in those to the east of it, sufficiently large for railroad ties; and although it will require transporting for long distances, it is believed to be sufficiently abundant for the construction of the road.

The open valley of Humboldt river immediately succeeds this section, and should be followed for about 180 miles. No other description is necessary of this direct and valuable passage across the Basin than that given in an extract from Colonel Frémont's Geographical Memoir addressed to the Senate, appended to the journal of the 22d of May, in the preceding part of this report.

The country to the south of this valley consists of an alternation of narrow mountains and valleys rapidly succeeding each other. The mountains have a general north and south course, but not unfrequently vary many degrees from that general direction, and, occasionally, cross chains are seen, closing the valleys to the north and south; but large spurs more frequently extend out from succeeding chains, and unite to form cross ranges, or overlap and obstruct the view. They are sharp, rocky, and inaccessible in many parts, but are low and easily passed in others. Their general elevation varies from 1,500 to 3,000 feet above the valleys, and but few of them retain snow upon their highest peaks during the summer. They are liberally supplied with springs and small streams, but the latter seldom extend far into the plains. At the time of melting snows they form many small ponds and lakes, but at others are absorbed by the soil near the bases of the mountains. Grass is found in abundance upon nearly every range, but timber is very scarce, a small scattered growth of cedar only being seen upon a few ranges. The valleys rarely extend uninterruptedly east and west, to a greater width than five or ten miles, but often have a large extent north and south. They are very irregular in form, frequently extending around the ends of mountains, or are united to succeeding valleys by level passages. They are much less fertile than the mountains, but generally support several varieties of artemisia, relieving them from the character of barrenness or desert. There are, however, many barren spots in each of these valleys, and the soil is seldom one half covered with vegetation, even for a few acres, while the great mass of it is merely sprinkled by the sombre artemisia foliage, presenting the aspect of a dreary waste, unrelieved by inviting shades, grassy plats, and floral beauties, and is nowhere suitable for settlements and cultivation. The accompanying profile of the line which we traversed in this part of the Basin, will serve to convey a general idea of its formation. From Humboldt river, there are three lines which may be followed to the foot of the Sierra Nevada. That by the Noble's Pass road, leaving the river a few miles to the east of where we returned to it, is the most direct, and is believed to be the best, as it avoids the principal range of mountains which we crossed on the line followed a few miles to the south of this, the two lines uniting on the shore of Mud lake. By the line followed, it is necessary to cross two ranges of the general character of the Basin mountains. The third line leads from the sink of the Humboldt to Pyramid lake without obstruction; but of the line passing thence by its shores to Honey Lake valley, little is known. It is 119 miles by the line followed from Humboldt river to the west shore of Mud lake, at the foot of Madelin Pass; but the northern line will diminish this distance at least one-fifth. The fertility of this section corresponds with that of the line south of Humboldt river. The northern route

explored across the Sierra Nevada, to which I have given the name of Madelin Pass, ascends the eastern slope of the mountains from Mud lake through the valley of Smoky creek. In leaving the lake valley, the pass leads for three miles through a narrow gorge in an outlying range of the Sierra Nevada. The sides of this gorge are formed of coarse, crumbling metamorphic rocks, much broken by side ravines. They rise very abruptly to the height of from 50 to 200 feet above the stream on the south side, and to a much greater elevation on the north side, swelling up two miles back into the high mountain ridge. The course of the gorge is direct, and varies in width from 100 to 15 yards, and can be followed without difficulty by a railroad. Above the gorge the valley of the creek expands to the width of half a mile at first, and afterwards of a mile; but again becomes narrowed to a ravine seven miles from the gorge. This valley is enclosed on the south side, except at a single point broken by a creek followed by Noble's road, by a precipitous rocky wall, rising at once to the level of the terrace above, which extends back to the foot of a high peak standing immediately at the summit of the pass. On the north side the valley is enclosed for seven miles by retreating mountain spurs, upon which a road can easily ascend to the terrace, which, in its eastern portion, is but a mile in width, with sloping ridges rising above it. Above this, however, it expands to the width of ten or twelve miles, but again becomes narrow as it approaches the summit of the mountain, where the grassy ascent is but 200 yards wide, with rocky hills rising gently two or three hundred feet above it. The soil of the pass is light, and the surface thickly covered with stones. Its width, and the character of the hills gradually rising above it in all parts, afford the means of ascending it by a very uniform grade. The length of the ascent is 22.89 miles by the direct line which we followed, and the difference of elevation of the extreme points 1,172 feet—the altitude of the summit being 5,667 feet above the sea. The latitude of our camp at the western base of the high peak was 40° 48′ 46″. The pass leads around this elevated peak, and by a gentle descent for five miles enters upon the broad, level plain of the summit of the mountains, extending for forty miles to the west; its width, north and south, varying from ten miles to mere open passages of a few hundred yards. No water is discharged from this plain, which receives the waters of a few small streams and springs forming grassy ponds. The irregular spurs, ridges, and isolated buttes rise but a few hundred feet above it, and are sparsely covered with a growth of cedar to the east, but with heavy pine forests to the west. In leaving this plain to cross the low ridge enclosing it to the west, the line enters a ravine valley a quarter of a mile wide, smooth and gradually ascending for a mile. It then expands to the width of a mile, and is grassy and smooth, and still ascends gently; but it again becomes narrowed to a quarter of a mile, and rises more considerably for the last half mile to the summit. The ridges rise gently on either side of the ascent, and are finely rounded and grassy, and it will be easy, by winding on these spurs, to increase the length of the approach somewhat, and to equalize the ascent; and the summit can readily be cut so as to diminish the altitude to be overcome 100 or 120 feet. The elevation of this point is 500 feet above that of the preceding plain, and 5,736 feet above the sea, and is the highest point in the pass, from which the descent is directly upon the waters of the Sacramento river. This descent is at first rapid and the ravine narrow; but it soon widens, and a creek descends from it with a free current. Spurs of the mountains, separated by ravines, project into the valley of this creek, leaving a direct and free passage, however, of fifty or sixty yards in width in the narrowest parts, and frequently expanding to half a mile. The descent is grassy and heavily timbered. For some miles from the summit, it will be easy to carry a road on the hillsides, descending at pleasure; but lower down it will become more difficult on account of the curves required for passing the side ravines, but it is still practicable. For this purpose the northeast side is the most favorable; for, although it contains the largest number of ravines, it is free from cañones, while the opposite side is obstructed by a formidable one five miles below the summit, and a second three miles below this. The length of the descent to the broad open plain of Round valley, to

which it leads, (on the Sacramento,) is fifteen miles, one half of which must be effected by following the mountain side. The total descent is 1,300 feet.

Round valley, through which the Sacramento river descends from the northeast, and through which a road can be carried at pleasure, extends for 15 miles below this point to the head of the first cañon of the Sacramento. This cañon is a formidable obstacle to be overcome. Its entire length is 13.74 miles, succeeded by an open valley of similar extent, which is followed by another cañon 8.95 miles in length, of the same character as the first. The river, as it enters the first cañon, is from 30 to 40 feet wide, flowing with a rapid current over a bed of rocks; and it is 60 feet wide as it enters the second cañon, just below the junction of Fall river, and flows over a similar bed with an equally swift current. At their heads these cañones are vertical trachytic rocks, 80 feet high, with large masses of fallen rocks accumulated at the bases of the walls. The first is cut through a high plain for six miles; the plain then rises somewhat, and is surmounted by high sloping ridges rising five or six hundred feet above it, and the cañon becomes much broader, and its walls more elevated for two miles, to where it makes a large bend to the north; below this the walls gradually decrease, and in two miles the cañon opens to the width of half a mile, which it preserves for three miles to the succeeding valley. The highest portions of the walls rise 200 feet above the stream, with an accumulation of fallen rocks extending half way to the top. For eight miles the course of the cañon is direct. It then makes a long bend to the north, and is followed by two or three short curves, but with a generally direct course. Its open part is timbered, and its walls less abrupt; and on the right bank of the stream, the mountains, followed by the river, extend considerably into the plain of Fall river. The most favorable line for the passage of a railway leads along the plain on the north side of the river, and descends the sides of the rocky hills which surmount it, and continues on the side of the mountain until it enters the plain of Fall river. The second cañon is only less formidable than the first because of its less extent. Its character is entirely the same, except that it is surmounted near its head by sloping mountain ridges of a similar altitude to the former. But on the south side, a few miles distant, the ridge subsides into rocky volcanic hills and plains. It will require a minute survey to determine the most practicable line by which to pass it; but it is probable that the best line will be found to leave the river a few miles above Fall river, and to pass around the ridge extending southward, and again return to the Sacramento at the mouth of Canoe creek, four miles below the foot of the cañon, avoiding short curves, which must be encountered in it, and diminishing the amount of rocky cutting; for in the passage of each of these cañones, the expense will be very heavy from this cause, and can only be estimated after an extensive and complete survey.

For 96 miles below the mouth of Canoe creek, to 17 miles above Fort Reading, the course of the Sacramento lies entirely through heavily timbered mountains, which rise precipitously from the river banks to the height of from 1,500 to 2,000 feet above the stream. Its course is winding, with all varieties of curves greater than a right angle, and it is seldom entirely straight for two miles consecutively, but its general courses are more uniform.

The foot of the mountains along the stream is often obstructed by fallen rocks to such an extent as to prevent its passage on horseback, and it is also obstructed by fallen timber and dense thickets of bushes; but the obstructions from fallen rocks are favorable rather than otherwise, for the construction of a railroad, as they will serve to form its sub-structure. At many points, but for short distances only, the way is obstructed by rocks in place. The road will require to be carried on the side of the mountains, a few feet above the stream at high water, throughout this entire section to the open valley of the Sacramento, whence it can be continued on the open plain. The latitude of our camp, near the northwest angle of the river, was 41° 03′.

The southern or Noble's pass of the Sierra Nevada (which I explored) branches from Madelin Pass, and the general line followed, on the western shore of Mud lake, which it follows to its southwestern termination, where it approaches nearest to Pyramid lake. It then turns more

to the west, and follows, for nine miles, an open passage of a mile in width, leading from Mud Lake valley to that of Honey lake. This valley extends 40 miles to the west, and is 20 miles wide in its broadest part, north and south. On the south it is enclosed by a high unbroken mountain range, and on the north by the outlying ranges, more or less broken, of the Sierra Nevada. The lake is about 15 miles in length and 8 or 10 in width. Its water is bitter. The head of the valley to the west is very fertile, and a settlement has been commenced in it, and will doubtless be continued. It is situated upon Susan river, which descends through the broad mountain depression followed by Noble's road to the summit of the Sierra Nevada. For seven miles above the valley this stream descends through a deep rocky cañon, frequently with vertical walls towards its lower portion, but more or less fallen and open above. It is also much broken by side ravines, and spurs of mountain ridges occasionally extend to it. In leaving the valley, outside of this cañon, there is, at first, an abrupt terrace rise, followed by the road, which continues along the sides of the ridges to the right of the ascent by a much less gradual and uniform ascent than that of the stream.

Seven miles above the valley the cañon becomes an ordinary ravine, and disappears about five miles higher up, where the mountain becomes broad and undulating, with irregular ridges rising above the general level, but still continues to rise to the vicinity of Pine creek, whence it continues its rolling character to Black Butte creek. It is doubtless practicable to accomplish the ascent of the first section of this pass, either by following the river or by rising as soon as practicable above its rocky walls, and following its general course above its cañon. By following the river, it will be necessary to carry the road on a rocky ledge, but the grades will be comparatively easy. The ascent by the terrace line will require an approach commencing on the foot of the mountain north of the pass, and rising gradually to the top of the cañon walls; and above this will encounter broad ravines for 12 miles. From this point to Black Butte creek, 31 miles, the construction of the road will be easy. From Black Butte creek, there is still a heavy rise for 12 miles to the west side of Black Butte. For the first eight miles the line follows the valley of the creek, and the foot of the mountain enclosing it to the west, (for the course is southward.) It then passes to the south around a large field of lava rocks, and, on a return curve to the north, passes to the west of Black Butte, and is continued thence to the west side of Hat creek without a material change of level, and is continued thence on the side of the mountain spur, extending into Canoe creek valley, and separating Hat from Wolf creek, and crosses the latter nearly on a level with the former, and is continued, two miles, to the western summit of the range on the side of the range itself. The length of this section from Black Butte creek is 35 miles, and the highest point upon the pass is found on it a short distance west of the Black Butte, and is 6,275 feet above the sea. The descent from the western summit is by a broad, heavily timbered ridge, lying between Bear Creek valley on the north and deep rocky chasms on the south. Its length is forty miles, with a variable width of from one and a quarter to six miles. Its altitude at the summit is 6,074 feet above the sea, and more than 5,000 feet above the foot of the ridge. Its character and the difficulties of its descent will be best understood by a reference to the preceding journal for the 12th of July, and the table accompanying it. By the residents in the lumber district of the descent, we were informed that in the vicinity of their mills they had never seen the snow more than four or six inches deep at any time during the winter, and that it never remained upon the ground for more than a week at a time in sufficient quantities to enable them to use sleds in their vocation. About the 10th of last January, Dr. Wozencraft, of California, with a small party, ascended this pass to its summit on a tour of exploration. They found the snow on the entire route, as they certify in a note placed in my hands by Dr. Wozencraft, "to average six inches in depth, and nowhere reaching eight or ten inches in its average fall. But," they say, "we encountered one drift of snow on the eastern slope of the Sierra Nevada, in a ravine extending a mile, averaging two feet or two feet and a half in depth." The entire length of the pass from Roop's farm, at the head of Honey Lake valley on the east, to the foot-hills of the Sierra Nevada on

the west, is 110 miles, and its termination is at the head of steamboat navigation, in a fertile and cultivated portion of the Sacramento valley, which extends unobstructed to the tide-waters of the Pacific.

Further surveys upon this route would doubtless develop important improvements at various points; and at two, at least—one from the shore of the lake near Stansbury's island, by Pilot Peak, to the pass in the Humboldt mountains; and the other in crossing from Humboldt river to Mud lake—would probably diminish the length of the line by 106 miles. The grades, also, are doubtless susceptible of material improvement by minute surveys with the spirit-level, by which the irregular atmospheric variations, which more or less affect barometric observations, will be entirely avoided. This method of determining levels with limited means, on so extensive a line, infested throughout by hostile savages, in the brief time allowed for these explorations, was not practicable, nor was it necessary; for the accuracy of the method employed is quite sufficient for the determination of the general profile of the route.

There is an abundance of good stone for bridges and building purposes at short intervals upon all parts of this line. Water is also found in abundance for railroad purposes throughout those portions of the Sierra Nevada, Wahsatch and Rocky mountains explored, and also at a few miles intervals in the Basin, where it usually occurs in springs at the bases of the mountains, and in small streams descending from the higher peaks and ridges to the adjacent plains. And a simple reference to the map of the route will exhibit an important feature in the fact, that in its remarkably direct course, for its great length, from the Missouri west to the Pacific, it follows the ascending and descending valleys of permanent rivers and their tributaries for more than two-thirds of its entire length, and that water is abundant on all the intermediate spaces—affording the means of irrigation to a large extent wherever the lands are suitable for it; and that they will doubtless be found so wherever the sage plains are luxuriant, may be inferred from the rich aromatic odor and resinous properties of that plant, and from the exceedingly nutritious character of the grass scattered through it. And it is a well known fact, that the Mormons produce some of their finest crops from reclaimed sage plains.

By reference to the map and accompanying table of latitudes, it will be seen that the route explored conforms throughout to a remarkably straight line, deviating, west from Fort Bridger, only at the Timpanogos cañon, if that line be preferred to the Weber, and on the northern portion of the Sacramento river; and then only by 3 minutes and 4 minutes, respectively, from the line of the 41st parallel of north latitude. The length of this route from the Missouri to the Black Hills may be safely estimated not to exceed 647 miles, the distance given by Captain Stansbury from Fort Leavenworth to Fort Laramie, (outward journey); and his distance from the Black Hills to Fort Bridger, 347 miles, is given from actual measurement. From Fort Bridger to Fort Reading, by the line of the accompanying profile, the distance is 1,011.71 miles, (which may hereafter be diminished by at least 106 miles, as before pointed out,) giving a total length for this line of 1,899.71 miles.

With much respect, I am, sir, your very obedient servant,

E. G. BECKWITH,

First Lieutenant, 3d Artillery.

CHAPTER VIII.

Tables of Distances, Grades, Altitudes, and Latitudes.

I.—Table of distances and of approximate average grades per mile upon the line explored for a railroad from Smith's Fork, near Fort Bridger, in the valley of Green river, Utah Territory, via the Madelin Pass, to Fort Reading, in the valley of the Sacramento river, California, 1854.

II.—Table of distances and of approximate average grades per mile upon the line explored for a railroad from Mud lake, via Noble's Pass, to Fort Reading.—July 4 to 26, 1854.

III.—Table of latitudes on the line of the forty-first parallel of north latitude, explored for the Pacific railway, 1854.

I.—*Table of distances and of approximate average grades per mile, upon the line explored for a railroad from Smith's Fork, near Fort Bridger, in the valley of Green river, Utah Territory, via the Madelin Pass, to Fort Reading, in the valley of the Sacramento river, California,* 1854.

Station.	Intermediate distances.	Total distances.	Average grades per mile.	Altitudes above the sea.	Remarks and dates.
			Feet.	*Feet.*	
Smith's Fork	----------	----------	----------	7254.4	April 11 and 12.
Black's Fork	----------	9.00	69.50	7880.3	April 10.
Divide between Black and Muddy creeks	2.25	21.25	40.30	8373.7	Do.
Divide of Muddy and Bear river	6.10	27.35	39.40	8133.3	Do.
Divide of Bear river and White Clay creek	12.90	40.25	49.80	7490.8	April 9.
White Clay creek	11.50	51.75	41.90	7009.0	April 17.
White Clay creek, camp 13	8.75	60.50	54.20	6534.4	Do.
White Clay creek, camp 4, east from Salt Lake	10.00	70.50	84.20	5602.1	April 7 and 8.
White Clay creek, camp 4	-------	----------	----------	5692.1	
Dry creek, camp 3	-------	16.50	16.50	5419.1	April 6.
Sheep Rock, Weber river	8.50	25.00	27.00	5189.5	Do.
Ben Simon's creek, camp 2	12.20	37.20	28.50	4842.1	April 5.
Weber river, below the mountains	7.80	45.00	53.60	4424.1	Do.
Weber river, camp 15	5.25	75.75	3.80	5671.9	April 19.
Weber river, Kamas prairie	12.00	87.75	54.00	6319.4	April 20.
Timpanogos river, Kamas prairie	8.70	96.45	8.80	6242.6	Do.
Timpanogos river	5.70	102.15	32.80	6055.5	April 21.
Timpanogos river, head of Round prairie	5.20	107.35	60.90	5738.8	Do.
Timpanogos river	5.00	112.35	44.40	5516.7	Do.
Timpanogos river, foot of Round prairie	0.70	113.05	32.70	5493.8	Do.
Timpanogos river, head of cañon	4.70	117.75	2.00	5484.3	Do.
Timpanogos river, in cañon	3.00	120.75	30.10	5394.1	Do.
Camp	8.00	128.75	39.70	5076.7	Do.
American Fork	14.20	142.95	19.80	5796.0	November 6, 1853.
Camp 2, west from Salt lake	39.60	182.55	3.50	4657.0	May 6, 1854.
Camp 3, west of Tuilla valley	20.59	203.14	8.10	4457.5	May 7 and 8.
Camp 4, opposite Stansbury's island	13.70	216.84	18.20	4238.0	May 8 and 9.
Camp 5, west side of Mt. creek, Spring or Lone Rock valley.	21.45	238.29	9.60	4444.3	May 9 and 10.
Dry creek	10.26	248.55	99.90	5469.7	May 10.
Entrance into Cedar Mt. Pass	1.54	250.09	38.20	5528.4	Do.
Camp 6, in pass	3.24	253.33	16.10	5580.5	May 10 and 11.
Summit of Cedar Mt. Pass	2.15	255.48	364.40	6364.0	May 11.
First descent of Cedar Mt. Pass	0.23	255.71	773.90	6186.0	Do.
Camp 7, west of Cedar Mt. Pass	1.30	257.01	470.00	5575.0	Do.
Foot of mountain	2.43	259.44	329.00	4775.5	May 12.
Camp 8, Granite mountain	17.33	276.77	0.50	4666.4	Do.
Fish creek	39.80	316.57	10.20	5073.2	May 15.
Camp 10, Fish creek	16.50	333.07	0.20	5076.5	Do.
Summit of mountain spur	14.13	347.20	76.30	6154.1	May 16.
Camp 11, in mountain pass	7.47	354.67	10.90	6073.1	May 16.
Ascent to divide of 1st and 2d creek of the pass	1.82	356.49	226.50	6485.4	May 17.
Ascent to divide between 1st and 2d creek of the pass	1.13	357.61	177.50	6684.2	Do.
Ascending 2d creek	1.25	358.86	26.20	6717.0	Do.

Table of Distances, Altitudes, and Grades—Continued.

Station.	Intermediate distances.	Total distances.	Average grades per mile.	Altitudes above the sea.	Remarks and dates.
			Feet.	*Feet.*	
Summit of pass	1.93	360.79	142.60	6992.2	May 17.
Camp 12, descending pass	1.42	362.21	311.20	6550.3	May 17 and 18.
Foot of mountain	8.38	370.59	61.60	6034.4	May 18.
Open valley, lake to the left	6.86	377.45	12.00	5952.4	Do.
Camp 13, Willow spring	3.22	380.67	28.90	5859.3	May 18 and 19.
Base of hill	3.30	383.97	79.40	6121.4	May 19.
Top of deep ravine	5.07	389.04	101.30	6635.2	Do.
Passing over a mountain spur	1.65	390.69	18.10	6665.1	Do.
On a spur of mountain	2.57	393.26	17.50	6710.1	Do.
On a spur of mountain	0.54	393.80	29.60	6726.1	Do.
Camp 14	2.92	396.72	192.10	6165.1	May 19 and 20.
Camp 15, Franklin river, on plain east of the Humboldt mountains.	21.52	418.24	7.50	6004.2	May 20 and 21.
Camp 16, Franklin river, extensive grass-fields	14.84	433.08	3.90	6061.4	May 21 and 22.
Crossing a mountain stream	7.65	440.73	58.20	6506.3	May 22.
Summit of pass in Humboldt Mt.	2.89	443.62	25.20	6579.1	Do.
On stream, western slope of pass	0.80	444.42	78.40	6516.4	Do.
Creek, valley of Humboldt river	8.36	452.78	89.20	5770.4	May 23.
Junction of main forks	35.00	487.78	30.60	4700.0	
Camp 33, east bank of Humboldt river	135.00	622.78	4.10	4140.9	June 8 and 9.
Crossing of Humboldt river, camp 34	6.80	629.58	0.90	4147.0	June 9 and 10.
Lassen's Meadows, California road, camp 35	3.51	633.09	1.50	4152.2	June 10 and 11.
Foot-hills above Humboldt river	9.64	642.73	16.30	4309.0	June 11.
In bed of dry creek	7.86	650.59	23.30	4492.0	Do.
In bed of dry creek	6.93	657.52	64.50	4938.7	Do.
Summit of pass	5.50	663.02	97.20	5473.2	June 12.
Descending from pass	10.55	673.57	87.20	4553.1	Do.
Junction of dry creeks	4.68	678.25	30.50	4410.5	Do.
Bed of dry creek	1.85	680.10	73.20	4275.0	Do.
In valley	2.55	682.65	1.30	4278.2	Do.
Dry creek	8.17	690.82	21.20	4451.5	June 13.
On stream, in cañon	1.95	692.77	67.60	4583.3	Do.
On summit	1.37	694.14	206.50	4866.2	Do.
Descending into valley	2.55	696.69	40.30	4763.4	Do.
Passing small hill in valley	7.04	703.73	44.40	5076.2	Do.
Passing small hill in valley	2.54	706.27	17.00	5033.0	Do.
Valley of Mud lake	11.75	718.02	76.50	4134.0	Do.
Point of Mountain, lake valley	15.39	733.41	00.00	4134.0	June 14.
East base of Sierra Nevada	9.88	743.29	1.60	4118.1	June 15 and 16, Camp 39.
Point of mount, shore of Mud lake	3.00	746.29	13.00	4079.0	June 16.
Foot of Madelin Pass, Smoky creek	16.00	762.29	18.20	4370.0	June 21.
Smoky creek, head of small cañon	3.00	765.29	41.70	4495.2	Do.
Smoky creek, ascending pass	3.00	768.29	61.40	4679.5	Do.
Smoky creek, ascending pass	2.50	770.79	59.10	4827.3	Do.
Smoky creek, ascending pass	2.50	773.29	74.90	5014.6	Do.
Ascent of the Sierra Nevada	3.56	776.85	8.60	5045.3	June 22.
In a broad valley, ascending pass	1.55	778.40	76.30	5163.5	Do.
In a broad valley .....do	1.56	779.96	78.30	5285.6	Do.
In a broad valley .....do	1.55	781.51	94.50	5432.1	Do.
In a broad valley	1.56	783.07	50.90	5511.5	June 22.
Ascent	1.32	784.39	100.00	5643.5	Do.
Summit of Madelin Pass	0.79	785.18	30.40	5667.5	Do.
On broad summit of Sierra Nevada	2.00	787.18	24.70	5620.0	Do.
On broad summit of Sierra Nevada	1.98	789.16	31.80	5557.0	Do.
On broad summit of Sierra Nevada	1.94	791.10	66.80	5427.5	Do.
Camp 45, broad plain, Sierra Nevada	3.85	794.95	46.00	5250.5	June 22 and 23.
Camp 47, broad plain, Sierra Nevada	21.90	816.85	0.50	5239.1	June 24 and 25.
Water-course	10.57	827.42	32.80	5585.5	June 25.
On divide in pass	1.63	829.05	92.30	5736.0	Do.
	1.63	829.05	18.70	5616.0	Deep Cut.
	2.42	831.47	124.10	5315.6	
Stream west of summit of the Sierra Nevada	2.42	831.47	173.70	5315.6	June 25.
Stream west of summit of the Sierra Nevada	1.73	833.20	62.50	5207.5	Do.
Base of hill, in valley	3.20	836.40	86.00	4932.2	Do.
Waters of the Sacramento river	3.67	840.07	125.40	4472.0	June 26.
East of stream, in Round valley	2.25	842.32	25.00	4415.7	Do.
Base of hill, in Round valley	2.08	844.40	10.00	4395.0	Do.
Leaving creek	1.25	845.65	76.60	4299.2	Do.
Camp 49, west side of stream	8.81	854.46	19.50	4127.4	Do.

Table of Distances, Altitudes, and Grades—Continued.

Station.	Intermediate distances.	Total distances.	Average grades per mile.	Altitudes above the sea.	Remarks and dates.
			Feet.	*Feet.*	
Foot of Round valley, head of first cañon of Sacramento river.	4.76	859.22	5.60	4153.9	June 27.
Foot of first cañon of Sacramento	13.74	872.96	38.70	3622.4	June 29.
Mouth of Fall river, and head of second cañon	13.50	886.46	27.60	3249.9	Do.
Sacramento river, mouth of second cañon	8.95	895.41	35.00	2937.0	July 21.
Mouth of Canoe creek	4.70	900.11	14.90	2867.2	Do.
Sacramento river	22.50	922.61	30.70	2177.2	July 20.
Sacramento river, Camp 5, ascending from Fort Reading.	7.50	930.11	59.60	1730.3	Do.
Sacramento river	26.50	956.61	21.70	1156.0	July 18.
Sacramento river, Camp 3	4.70	961.31	16.60	1078.1	July 17.
Sacramento river, Camp 2	10.50	971.81	11.80	954.2	Do.
Mouth of McCloud's river	5.25	977.06	6.10	922.0	July 16.
Sacramento river	11.75	988.81	7.20	837.5	Do.
Fort Reading	22 90	1011.71	7.10	674.7	July 12 to 15.

II.—*Table of distances and of approximate average grades per mile upon the line explored for a railroad from Mud lake, via Noble's Pass, to Fort Reading.—July* 4 *to* 26, 1854.

Station.	Intermediate distances.	Total distances.	Average grades per mile.	Altitudes above the sea.	Remarks and dates.
			Feet.	*Feet.*	
Camp 39, east base of the Sierra Nevada	.....	.....	.....	4118.1	June 15 and 16.
Shore of Mud lake	3.00	3.00	13.00	4079.0	June 16.
Warm springs	42.00	45.00	3.60	4231.6	July 5.
Old shore-line	7.50	52.50	7.10	4285.2	Do.
Camp 55, shore of Honey lake	8.50	61.00	22.40	4094.6	July 4, 5, and 6.
Willow creek	11.36	72.36	1.30	4080.0	July 4.
Camp 54, Roop's rancho	8.64	81.00	11.70	4181.0	July 3.
Susan river	4.00	85.00	10.10	4221.4	July 8.
Susan river	4.00	89.00	105.50	4643.6	Do.
Susan river	4.50	93.50	59.10	4909.7	Do.
Divide of Susan and Summit creeks	7.25	100.75	75.10	5454.1	July 9.
Lake or pond	7.25	108.00	31.10	5679.4	Do.
Divide of Summit and Pine creeks	2.25	110.25	54.30	5801.6	Do.
Pine creek, prairie	5.00	115.25	27.70	5663.3	Do.
Plains of the Sierra Nevada	2.89	118.14	63.30	5480.5	Do.
Plains of the Sierra Nevada	1.84	119.98	19.50	5516.3	Do.
Thick pine woods	1.70	121.68	71.90	5394.1	Do.
Thick pine woods	2.05	123.73	64.90	5261.1	Do.
Camp 59, Black Butte creek	1.55	125.28	113.70	5084.8	July 9, 10, 23, 24.
Bed of dry creek	11.69	136.97	101.80	6275.4	July 10.
Near a pond	1.87	138.84	25.10	6223.4	Do.
Small creek and springs	1.53	140.37	19.00	6194.3	Do.
Canoe creek	3.75	144.12	5.80	6216.2	July 24.
West of Hat creek, side of mountain	2.75	146.87	45.10	6092.3	Do.
Spur dividing the valleys of Wolf and Hat creeks.	0.50	147.37	154.40	6015.1	Do.
Wolf creek	1.50	148.87	21.30	5983.1	Do.
Western summit of Sierra Nevada	2.00	150.87	45.50	6074.1	July 25.
Battle creek	5.00	155.87	49.80	5825.1	Do.
Battle creek	2.50	158.37	212.60	5293.6	July 11.
Western descent of Sierra Nevada	2.12	160.49	284.00	4691.5	Do.
Deer Flat, rancho	2.14	162.63	174.50	4318.1	Do.
Western slope of Sierra Nevada	1.69	164.32	101.70	4146.3	Do.
Hill's rancho, on Battle creek	2.00	166.32	7.30	4131.6	July 25.
Descending Sierra Nevada	4.14	170.46	47.60	3934.7	July 11.
Descending Sierra Nevada	3.58	174.04	136.60	3445.7	Do.
Camp 61, McCumber's mill	1.00	175.04	54.60	3491.1	July 12.
On stream	2.38	177.42	2.80	3497.8	Do.
Descent	3.05	180.47	230.10	2796.0	Do.
On stream	2.19	182.66	235.50	2280.2	Do.
Descent in valley	3.78	186.44	186.20	1576.4	Do.
Descent in valley	2.93	189.37	166.90	1087.4	Do.
On Dry creek	2.54	191.91	78.80	887.3	Do.
On Dry creek	4.37	196.28	41.40	706.5	Do.
Camp 62, Fort Reading	2.25	198.53	14.10	674.7	July 12, 13, 14, 15.

III.—Table of latitudes on the line of the forty-first parallel of north latitude, explored for the Pacific railway, 1854.

SIR: In the following table of geographical positions, the latitudes are all deduced from meridional observations, and, when practicable, both north and south culminating stars were observed, for the purpose of eliminating instrumental and other errors.

The astronomical instruments were the same as those used last year with Captain Gunnison, and pronounced by him entirely inadequate for the determination of longitude. They were, besides, very much out of repair and adjustment when we started from Westport—defects which could not be remedied in Salt Lake City.

Very respectfully,

SHEPPARD HOMANS,
In charge of Astronomical Department.

First Lieut. E. G. BECKWITH,
U. S. A., Commanding Expedition.

Geographical positions from Green river, Utah Territory, to Fort Reading, California, via Salt Lake City.

Date.	Locality.	Star.	Double mer. alt.	Index error.	Corrected altitude.	Deduced latitude.	Latitude of camp.
1854.				′ ″			
April 15	Muddy creek	Alpha Hydra	81 12 30	15 12.5	40 42 29		41 15 43
16	Bear river	do	81 28 45	15 47	40 50 54		41 07 18
17	White Clay creek	do	81 47 30	16 22.5	41 00 34		40 57 38
19	Weber river	do	81 57 30		41 05 34		40 52 38
1853.							
Dec. 6	Salt Lake City	Sun	52 49 00	1 37	26 39 51		40 45 37
1854.							
May 9	Lone Rock valley	Spica	78 12 40	10	39 05 13		40 30 46
12	Camp 8, Granite mountain	do	78 48 45	15	39 23 22		40 12 37
16	Camp 11	do	79 03 05	15	39 30 24	40 05 35	
16	do	Polaris	77 18 00		38 37 55	40 06 14	40 05 55
17	Camp 12	do	77 14 20	5	38 36 10	40 04 29	
17	do	Spica	79 04 40		39 31 22	40 04 37	40 04 33
18	Willow spring	Polaris	77 34 00		38 45 59	40 14 18	
18	do	Spica	78 45 35		39 21 50	40 14 09	40 14 14
19	Camp 14	Polaris	77 50 45	12.5	38 54 18	40 22 37	
19	do	Spica	78 27 40		39 12 45	40 23 14	40 22 56
20	Franklin river	Polaris	78 15 10	15	39 06 23	40 34 43	
20	do	Spica	78 04 10		39 00 58	40 35 01	40 34 52
21	do	Polaris	78 29 40	5	39 13 52	40 42 12	
21	do	Spica	77 50 40		38 54 20	40 41 39	40 41 50
26	Camp 20	Polaris	78 05 10	2.5	39 01 37	40 29 58	
26	do	Spica	78 14 35		39 06 20	40 29 39	40 29 49
27	Camp 21	Polaris	77 44 30		38 51 15	40 19 36	
27	do	Spica	78 35 15		39 16 39	40 19 20	40 19 28
30	Camp 24	Polaris	77 34 45		38 46 23	40 14 44	
30	do	Spica	78 44 30		39 21 14	40 14 44	40 14 44
31	Camp 25	Polaris	77 27 30	10	38 42 43		40 11 04
June 3	Camp 28	do	77 32 10		38 45 01		40 13 23
4	Camp 29	Spica	78 38 30	12.5	39 18 14		40 17 45
7	Camp 32	Polaris	78 10 35		39 04 12	40 32 34	
7	do	Spica	78 11 35		39 04 52	40 31 07	40 31 51
10	Lassen's meadows	Beta Libra	80 58 35		40 28 21		40 42 03
16	Mud lake	do	80 57 05		40 27 37		40 41 48
19	Madelin Pass	do	80 52 10		40 25 13		40 44 12
20	do	do	81 03 30		40 30 51		40 38 35
22	Camp 45	do	80 43 10		40 20 39		40 48 46
23	Camp 46	do	80 50 10		40 24 10		40 45 15
24	Camp 47	do	80 40 20		40 19 12		40 50 14
25	Camp 48	do	80 13 20		40 05 42		41 03 43
26	Camp 49	do	80 11 10		40 04 36		41 04 49
27	Camp 50	do	80 23 10		40 10 38		40 58 47
30	Camp 51	do	80 37 10		40 17 39		40 51 46
July 1	Camp 52	do	80 54 40		40 26 25		40 43 00
2	Summit creek	Antares	46 48 50		23 22 36		40 31 02
3	Roop's rancho	do	47 01 50		23 28 52		40 24 46
4	Shore of Honey lake	do	47 09 00		23 32 42		40 20 56
9	Black Butte creek	do	46 33 40		23 15 00		40 38 38
10	Wolf creek	do	46 40 50		23 18 35		40 35 03
15	Camp	do	46 28 30		23 11 55		40 41 43
17	Sacramento river	do	46 20 40		23 08 04		40 45 34
18	do	do	46 17 00		23 06 22		40 47 16
19	do	do	45 47 00		22 51 17		41 02 21
20	do	do	45 45 40		22 50 38		41 03 00
21	Camp near mouth of Canoe creek	do	45 58 30		22 57 03		40 56 35
26	Near Fort Reading	do	46 51 40		23 23 36		40 30 02

CHAPTER IX.

Meteorological Observations, and Tables of Altitudes and Distances.

I.—Introduction to meteorological table and table of altitudes and distances, on the line of the forty-first parallel of north latitude, explored for the Pacific railway.

II.—Meteorological table at Great Salt Lake City during the winter of 1853–'54.

III.—Summary of meteorological observations at Great Salt Lake City in 1853 and 1854, in mean results at each observed hour for the several months; barometric reading corrected for temperature.

IV.—Barometric means for the months observed at Great Salt Lake City, 1853–'54, from all the observations, including those at irregular hours, and corrected in detail for horary variation of pressure.

V.—Meteorological observations and table of altitudes and distances from Great Salt Lake City to Green river, April, 1854.

VI.—Data for profile from Smith's fork, Green River valley, to that of Great Salt Lake, via the Timpanogos river.

VII.—Data for profile from Great Salt Lake valley, via the Weber river, to White Clay creek, the preceding profile being in common with this from the latter point eastward.

VIII.—Meteorological observations and table of distances from Great Salt Lake City, Utah Territory, to the valley of the Sacramento river, California, 1854.

IX.—Meteorological observations and table of altitudes from Mud lake, via Mud creek, to the summit of the Sierra Nevada and to Madelin Pass. (Table not used in profile.)

VIII.—Continuation of Table VIII.

X.—Meteorological observations and table of altitudes in crossing from Madelin to Noble's Pass, on the summit of the Sierra Nevada. (This table is not used in profile.)

VIII.—Table VIII again resumed.

XI.—Meteorological observations and table of altitudes and distances for profile from Mud lake to Fort Reading on the Sacramento river, California, via Noble's Pass.

XII.—Meteorological observations and table of altitudes on the road leading through Noble's Pass.

XIII.—Meteorological observations and table of altitudes in crossing from the mouth of Canoe creek (Poinsett river) to Black Butte creek, and thence west to Hat and Wolf creeks. (This table is not used in profile.)

I.—*Introduction to meteorological table and table of altitudes and distances on the line of the forty-first parallel of north latitude, explored for the Pacific railway.*

The Bunten barometers Nos. 496 and 551 are exclusively relied upon for the determination of altitudes of the entire line. The readings of the Aneroid barometers exhibit variable errors; and as the mercurial barometers retain their reliable and uniform character throughout, no necessity exists for the use of the Aneroids. The zero errors found by Dr. Engelmann in his comparison at St. Louis, to apply to the Bunten barometers before the commencement of the work, did not remain as between the two instruments, even at the first considerable camps of the survey; they were therefore rejected in all the computations, and no zero error was at any time applied. For mean readings the two barometers usually agreed very nearly, the difference between them being, that No. 496 was too slow in its movement when considerable changes of altitude occurred, and required a correction or substitution of the other in such cases. For mean readings at stations where several observations were taken, the results of both are believed to be a very near approximation to standard accuracy, and the instruments appear to have been but slightly, if at all deranged at the termination of the survey. The zero errors found in them by Dr. Engelmann, on their return, were obviously introduced after the close of the work, and are therefore not applied to it.

In the discussion of the observations, the readings were first corrected for temperature to the height of the mercurial column, at 32° Fahrenheit. A minor error of non-adaptation of the common formula to the temperature expansion determined by Shumacher for barometers of this

construction is thus avoided, and the greater advantage gained of combining all the observations at a station in a correct mean reading, to be used in a single computation of the altitudes. The mean of the observed air temperature is used in these cases also, as avoiding to some extent a source of error in extremes of surface temperature, for which, in single observations, a table of corrections is appended. All the observations were also corrected for *horary variations* of atmospheric pressure through the day, thus bringing each to the true mean position for the day. The accompanying scale of horary corrections gives the value employed for each hour; they are derived primarily from well-determined curves of daily variations of pressure for the eastern United States, but with material and important modifications and additions established by the observations of other surveys in the interior of the continent, principally by that of Lieut. Whipple. By the observations through the winter months at Great Salt Lake City, the measures of this horary scale are shown to be less for that season, and to conform these more nearly than in summer to those observed in the eastern United States and in Europe. For the months occupied in the field-work of this survey, however, and for the districts traversed, the measure of the correction here employed is fully confirmed. At the sea-level, or so near it as both extremities of the line are, the measures of horary variation again fall off to those belonging to well known districts; yet as no determinations of importance occur at these extremities, it is not necessary to give the scale belonging to them. A correction previously found to be required for extremes of air temperature has been so well determined by the comparison of survey by levels and with the barometer, at the passes of the Sierra Nevada, surveyed by Lieut. Williamson, that a scale of corrections sufficiently precise for practical use has been constructed. When the error from this cause could not be eliminated by the use of mean temperatures, this scale has been employed in the determinations here made. The measures given for this correction belong to extremely arid climates, and to elevated districts, requiring modification in the position of the point where no correction is required; also in different seasons. As it affects great elevations in these arid districts by an extreme amount, of at least 150 feet, it is too important to be neglected, notwithstanding a discretionary use of the value is usually necessary.

The reduced observations at stations on the Plains, from Pawnee fork to camp 33, the first after crossing the Arkansas river, were referred to the mean barometric readings noted by Dr. Engelmann at St. Louis, for July, 1853, the month in which they were made.

The altitude of this station above the Gulf of Mexico, as determined by him from a long series of observations, was added to make up the entire altitude. For these stations and dates, the results thus obtained are very nearly identical with those computed by direct reference to the barometric mean at the level of the sea for the latitude.

For altitudes beyond this point, direct comparison of each camp is made to an assumed mean barometric reading at the level of the sea, in this latitude, of 30.000 inches, the barometer corrected to 32°, and a mean air temperature taken of 57°. The constant belonging to the latitude and climate of the Gulf is 30.050 inches of the barometer, and 64° of air temperature, which would add unduly to the altitudes.

The principle is assumed that the constants of pressure and temperature employed belong to the latitude, and that the resulting determinations of elevations belong, correctly and alike, to both the Gulf, the Atlantic and Pacific. There are no well-determined mean readings of the barometer on the Pacific coast, yet the most of those recently made in California give the impression that a slightly greater mean atmospheric pressure exists there than in the same latitude of the Atlantic. The constant has not, however, been altered for any portion of this line.

The discussion of observations at the principal passes has been, in part, upon simultaneous observations at an hour's interval in time and distance. The slower movement of one barometer, however, rendered it necessary in many cases to take successive readings of the best one, corrected for horary variation, for determinations of successive differences. The termini of these lines of ascent an descent were also checked by comparison of preferred results, as of the mean

of several at the summit or elsewhere, with the nearer camps. The coincidence of results by single and successive steps has been so satisfactory as to warrant the conclusion that the grades and altitudes of these passes are quite accurately determined. The correct use of such data in the joining of intermediate with main lines, and in the correspondence of single observations with the mean of observations, is the surest test of barometric survey, and discrepancies cannot be wholly removed. The principal cause of these discrepancies is in the non-periodic variation of atmospheric pressure, for which no constant or correction can be given, except by reference to continued readings for a month or more at some station near. Mean results best eliminate this error, and they are therefore preferred in the order of their number, or of the number of days they cover. In the ascent of the Arkansas, the uniform grade of the stream permits the use of four or five successive camps as a near result, and two or three non-periodic variations are thus eliminated. Subsequently, to Great Salt lake, a less error from this cause is likely to occur, as this variation is least in August and September.

For the survey eastward from Great Salt lake to the valley of Green river, the field readings are compared with those of the same date by the other barometer at Great Salt Lake City: these may be regarded as nearly simultaneous, (though the hours were not always the same,) from the fact that the same days, and portions of the day, were compared. For the remainder of the line to California, no mode of correction of this error existed, except in the preference of the means embracing the greatest number of observations; yet the errors have probably no practical importance.

The observations generally sustain the checking and criticism which rank the results as a determinate survey, with a near approximation to absolute accuracy, and, as among themselves, sufficiently conclusive of grades and points of comparison.

Horary corrections of the barometer.

Hour.	Inches.	Hour.	Inches.
6 a. m.	+.007	3 p. m.	—.030
7 a. m.	+.020	4 p. m.	—.045
8 a. m.	+.030	5 p. m.	—.050
9 a. m.	+.040	6 p. m.	—.030
10 a. m.	+.050	7 p. m.	—.020
11 a. m.	+.055	8 p. m.	—.005
12 m.	+.025	9 p. m.	—.000
1 p. m.	+.005	10 p. m.	+.010
2 p. m.	—.015	11 p. m.	+.020

Scale of corrections for extreme air temperatures.

Low temperatures.	High temperatures.
At 35° add 25°	At 95° subtract 15°
At 40 add 23	At 93 subtract 13
At 45 add 21	At 90 subtract 11
At 47 add 20	At 88 subtract 10
At 50 add 18	At 85 subtract 8
At 53 add 15	At 83 subtract 7
At 55 add 13	At 80 subtract 5
At 57 add 10	At 78 subtract 3
At 60 add 5	At 75 subtract 2

NOTE.—The measures of this correction are variable to some extent with the season, and apply nearly to departures from the mean of the month in which observations are made. It is here given as required for summer months, in which most of the observations in field surveys have been taken.

CAPTAIN GUNNISON'S BAROMETERS COMPARED WITH THE STANDARD BAROMETERS OF DR. ENGELMANN.

ST. LOUIS, *June* 4 to 9, 1853.

Ten observations were made.

Range of standard barometer in that period from 29″.505 to 29″.748. Range 0″.243.

Mean differences of standard and compared barometers.

Bunten, No. 551 = E + 0″.006. Bunten, No. 496 = E + 0″.080
Aneroid, No. 9889 = E — 0″.015. Aneroid, No. 9293 = E — 0″.025

Extreme differences of range of standard and compared barometers.

Bunten, No. 551 = E — 0″.021
Do. = E + 0″.027
} = 0″.048, range of difference.

Bunten, No. 496 = E + 0″.046
Do. = E + 0″.109
} = 0″.063, range of difference.

Aneroid, No. 9889 = E — 0″.055
Do. = E + 0″.035
} = 0″.090, range of difference.

Aneroid, No. 9293 = E — 0″.005
Do. = E — 0″.045
} = 0″.040, range of difference.

E. represents Engelmann's standard barometer.

Both Bunten barometers are very slow in their movements. B. No. 551 gives a very dull sound when the tube is reversed, indicating air in the tube. No. 496 gives a clear sound, and is probably free of air.

The station of Dr. Engelmann's barometer is above low-water mark of the Mississippi 106.5, and above the Gulf of Mexico 482 feet.

Bar. Engelmann was in June, 1853, equal to—

Bunten, No. 551 — 0″.006
Do. No. 496 — 0″.080

The Aneroids were both set to correspond exactly with bar. E.

After the voyage to California and back, bar. Engelmann was found in September, 1854, equal to—

Bunten, No. 551 — 0″.072
Do. No. 496 + 0″.116
Aneroid, No. 7889 — 0″.448
Do. No. 9293 + 0″.263

Therefore, as bar. E. has remained unaltered,

Bar. Bunten No. 551 is now higher by 0″.066 than 14 months ago.
Do. No. 496 is now lower by 0″.196 " "
Bar. Aneroid No. 7889 is now higher by 0″.448 " "
Do. No. 9293 is now lower by 0″.263 " "

Bunten No. 551 is by far the best instrument of the whole set; but both barometers have the sides of the tubes at the lower as well as the upper levels so much soiled and darkened by oxydized mercury, that at a certain elevation of the barometer, at least, the reading becomes very difficult, if not impossible.

The Aneroids are certainly very unreliable; but within the limited range of my observations, (between 29 and 30 inches,) they performed well and corresponded pretty accurately with the changes of my own barometer.

In calculating elevations from barometrical data, it seems best not to compare isolated observations made on the same day or at the same hour, but to refer the observations made in the

field (or the mean of several if they can be had) to the monthly means of the stationary barometer. I add, therefore, my monthly means for the last fourteen months. But the observations made west of the Rocky mountains cannot be referred to my barometer at all. It is hardly necessary to add—what everybody who is in the habit of observing the barometer knows—that observations made in the forenoon, principally from 8 to 10 o'clock a. m., are generally higher, and those made in the afternoon, principally between 2 and 4 o'clock, are mostly lower than the average of the day. The noon observations come nearest the mean of the day. The barometer, at least in the Mississippi valley, is usually highest with westerly and northwesterly winds, and lowest with southerly and southeasterly winds. It is mostly higher, but much more irregular, in winter, and lower, but more regular, in summer.

Mean barometric elevation of barometer E. at St. Louis, 482 feet above the Gulf.

Table of means corrected for temperature.

June,	1853	29.466
July,	1853	29.483
August	1853	29.431
September,	1853	29.474
October,	1853	29.538
November,	1853	29.601
December,	1853	29.508
January,	1854	29.577
February,	1854	29.507
March,	1854	29.459
April,	1854	29.444
May,	1854	29.334
June,	1854	29.418
July,	1854	29.491

G. ENGELMANN.

St. Louis, *September*, 1854.

The discrepancy found to exist by Dr. Engelmann in the Bunten barometers after our return from California did not exist as between themselves up to the termination of the exploration in July, and must have arisen from some cause on our homeward journey, and is disregarded, therefore, in the discussion.

Horary variations of the barometer in California.

1. In the elevated portions of the interior.

Hour.	Inch.	Hour.	Inch.
5 a. m.	—.007	2 p. m.	—.025.
5 a. m.	—.005	3 p. m.	—.030
6 a. m.	+.012	4 p. m.	—.035
7 a. m.	+.025	5 p. m.	—.033
8 a. m.	+.030	6 p. m.	—.025
9 a. m.	+.035	7 p. m.	—.015
10 a. m.	+.040	8 p. m.	—.005
11 a. m.	+.045	9 p. m.	+.008
12 m.	+.015	10 p. m.	+.015
1 p. m.	—.005	11 p. m.	+.013

2. At the sea-level, or near the coast.

Hour.	Inch.	Hour.	Inch.
4 a. m.	—.007	2 p. m.	—.025
5 a. m.	—.005	3 p. m.	— 030
6 a. m.	+.012	4 p. m.	—.035
7 a. m.	+.025	5 p. m.	—.033
8 a. m.	+.032	6 p. m.	—.025
9 a. m.	+.041	7 p. m.	—.015
10 a. m.	+.045	8 p. m.	—.005
11 a. m.	+.035	9 p. m.	+.008
12 m.	+.015	10 p. m.	+.015
1 p. m.	—.005	11 p. m.	+.013

II.—*Meteorological Observations at Great Salt Lake City*, 1853–'54.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1853.						*Inches.*	*Inches.*		
Great Salt Lake City, at the house of Mr. Benson, opposite the Council-house and Tithing-office.	Nov. 29	10 a. m.....	657	10.5	655.5	11	25.773	25.710	49	Rain in valley; snow in mountains; cool and unpleasant.
	29	12 m.....	655.4	10	654.3	10	25.735	25.692	50	Rain ceased to fall, but it still continues cloudy.
	30	9.30 a. m....	657.6	9.5	657.6	10	25.802	25.802	47	A few light clouds.
	30	12 m	657.9	12	658.5	12	25.822	25.849	51	Clear and pleasant.
	30	3 p. m.....	657.9	13	659.5	14	25.879	25.897	53	Clear and pleasant, with a slight breeze from the southeast.
	Dec. 1	9 a. m.....	658	10	658.3	10.5	25.823	25.834	46	Clear and pleasant.
	1	12 m.....	658	13.5	658.3	14	25.826	25.834	53	A few light clouds in the northwest.
	1	3 p. m	658	15.5	658.3	16	25.873	25.881	57	Clear.
	2	9 a. m.....	656.8	10.5	656.3	10.5	25.772	25.756	45	Clear; thermometer at sunrise 31°.
	2	12 m.....	657.7	13.5	656.5	14	25.810	25.763	52	Light clouds.
	2	3 p. m.....	656.5	14	655.1	14.5	25.818	25.763	55	Do
	3	9 a. m.....	656.5	11.5	655.1	12	25.756	25.701	48	Thermometer at sunrise 32°.
	3	12 m.....	656.5	13	655.2	13	25.767	25.716	53	Clear.
	3	3 p. m.....	656.5	13	655.2	13	25.822	25.771	54	Do.
	4	9 a. m.....	655.8	10	653.9	10	25.736	25.661	44	Thermometer at sunrise 31°.
	5	9 a. m.....	655	9	654.9	9.5	25.712	25.701	43	Do do. 30°.5
	5	12 m.....	655.7	12	655.6	12.5	25.739	25 731	50	Morning clear and cool.
	5	3 p. m.....	655.7	13.5	655.6	13.5	25.786	25.786	53	Clear and pleasant.
	6	9 a. m.....	659.4	9.5	658.9	9.5	25.878	25.858	43	Thermometer at sunrise 30°.
	6	12 m.....	659.6	12	659.2	11.5	25.893	25.881	51	Clear and pleasant.
	6	3 p. m.....	659.6	14	659.2	14.5	25.936	25.930	54	Clear.
	7	9 a. m.....	659.8	9	659.6	9	25.897	25.890	41	Thermometer at sunrise 28°.
	7	12 m.....	659.8	12	659.6	12	25.897	25.893	51	Clear.
	7	3 p. m.....	659.8	13	659.8	13.5	25.948	25.948	52	Clear and pleasant.
	8	9 a. m.	659	8	657.7	8	25.874	25.819	40	Thermometer at sunrise 28°.
	8	12 m.....	657.8	11.5	656.6	11.5	25.822	25.735	47	Morning clear and cool, with heavy frost.
	8	3 p. m.....	656.3	13.5	655	14	25.810	25.759	54	Clear.
	9	9 a. m.....	650.7	5	651.1	5	25.555	25.574	34	Thermometer at sunrise 26°.
	9	12 m.....	650.7	7	651.1	7	25.562	25.582	35	Heavy mist, with a cold northwest wind.
	9	3 p. m.....	648.8	8	650	8.5	25.538	25.589	37	Cloudy.
	10	9 a. m.....	647	6	648.5	6	25.409	25.464	36	Thermometer at sunrise 28°; cloudy.
	10	12 m.....	647	6	648.5	6	25.424	25.479	45	Cloudy; strong wind from northwest in the evening; rain.
	11	9 a. m.....	647.5	8.5	649.7	8	25.417	25.504	41	Cloudy.
	11	11 a. m.....	648.6	9	650.2	9.5	25.441	25.504	45	Do.
	12	9 a. m.....	652.6	8	652.2	8	25.618	25.602	37	Hazy and cloudy.
	12	12 m.....	652.3	8	652	8	25.621	25.713	39	Hazy.
	12	3 p. m.....	652	7.5	650.7	7.5	25.768	25.613	39	Cloudy.
	13	9 a. m.....	647.1	7	648.4	7	25.409	25.456	39	Thermometer at sunrise 26°; cloudy.
	13	12 m.....	646	8	647.3	8.5	25.377	25.494	46	Cloudy and disagreeable.
	13	3 p. m.....	645.2	8	647.3	8.5	25.491	25.479	48	Cloudy, with indications of rain.
	14	9 a. m.....	644.7	7	647	7	25.315	25.405	42	Thermometer at sunrise 40°; slight fall of snow.
	14	12 m.....	645	7	647.7	7	25.342	25.444	36	Cloudy and damp.
	14	3 p. m.....	645	7	647.7	7	25.397	25.499	41	Damp; snow in mountains.
	15	9 a. m.....	646.3	6.5	648.9	6.5	25.378	25.476	37	Thermometer at sunrise 33°.
	16	9 a. m.....	650.3	5	651.9	5	25.616	25.602	30	Thermometer at sunrise 26°; clear
	16	12 m.....	653.1	6	653	6	25.664	25.660	37	Cloudy
	16	3 p. m.....	653.1	6	653	6	25.719	25.715	37	Do.
	17	9 a. m.....	653.7	5	653.9	5	25.673	25.661	34	Thermometer at sunrise 33°; cloudy
	18	9 a. m.....	654.2	6.5	654.1	6.5	25.689	25.685	36	Thermometer at sunrise 30°; cloudy.
	19	9 a. m.....	652.2	5	651.2	5	25.614	25.578	31	Thermometer at sunrise 26°, clear.
	19	3 p. m.....	654.3	7.5	655.3	7.5	25.739	25.806	39	Cloudy.
	20	9 a. m.....	648.1	6	648.7	6	25.452	25.472	30	Thermometer at sunrise 35°, cloudy
	20	12 m.....	648.7	6	648.7	6	25.487	25.487	42	Cloudy
	20	3 p. m.....	648.3	7	648.7	7.5	25.522	25.534	48	Clouds; snow fell during the night to depth of four inches.
	21	9 a. m.....	648.7	7.5	648.5	7.5	25.488	25.460	37	Thermometer at sunrise 34°; snow falling very fast.
	21	12 m.....	648.7	7.5	648.5	7.5	25.482	25.475	43	Snow.
	21	3 p. m.....	648	6.5	648	6.5	25.515	25.515	37	Do.
	22	9 a. m.....	651.3	6.5	651.8	6.5	25.574	25.590	25	Thermometer at sunrise 24°; clear.
	22	12 m.....	651.6	8.5	652.8	8.5	25.593	25.637	31	Clear.
	23	9 a. m.....	652.3	5	653.6	5	25.618	25.660	23	Thermometer at sunrise 16°; clear.
	23	3 p. m.....	652.2	10	651.2	10	25.664	25.625	32	Clear.
	24	9.45 a. m....	651.6	4	650.2	4	25.587	25.540	20	Clear and cool.
	24	12 m	650.6	6	649.5	6	25.563	25.519	26	Thermometer at sunrise 20°; cloudy
	26	9 a. m.....	652.7	5	652.3	5	25.634	25.618	27	A few light clouds.
	26	12 m.....	652.6	6	652.3	6	25.641	25.629	37	Thermometer as sunrise 23°; cloudy.
	27	9.30 a. m....	653.5	6	653.1	6	25.656	25.644	28	Cloudy.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1853.						*Inches.*	*Inches.*		
Great Salt Lake City..	Dec. 27	12 m	653.5	8.5	653.1	8.5	25.664	25.653	44	Thermometer at sunrise 35°; cloudy.
	27	3 p. m.....	653.7	9	653.3	9	25.727	25.712	43	Cloudy.
	28	12 m.....	653	11	650	11	25.637	25.523	46	Do.
	28	3 p. m.....	650.6	10	648.7	10	25.601	25.526	49	Clear and pleasant.
	29	9 a. m.....	650.2	7.5	650	7.5	25.527	25.519	35	Cloudy; snow fell during the night to depth of three inches.
	29	12 m.....	650.2	8	650	8	25.538	25.534	35	Cloudy; strong wind from northwest.
	29	3 p. m.....	650.2	5.5	650	5.5	25.605	25.597	34	Cloudy; northwest wind.
	30	9.30 a. m....	656.3	4.5	656.2	4.5	25.774	25.770	24	Cloudy; slight fall of snow.
	31	9 a. m.....	659.8	5.5	659.8	5.5	25.909	25.909	25	Clear; thermometer at sunrise 18°.
	31	12 m	659.8	8	659.8	8	25.916	25.916	33	Clear.
	1854.									
	Jan. 2	9.30 a. m....	659	5.5	657.3	5·5	25.877	25.810	28	Clear; thermometer at sunrise 22°.
	2	12 m	659.3	9	657.7	9	25.893	25.830	34	Clear.
	3	9.30 a. m....	653.2	9	651.1	9	25.633	25.550	42	Cloudy.
	3	3.30 p. m....	651.3	12	648.7	12	25.628	25.526	47	Do.
	4	9 30 a. m....	647.1	9	646.3	9	25.396	25.365	35	Thermometer at sunrise 32°; light clouds.
	4	12 m	647.1	9	646.1	9	25.416	25.377	37	Cloudy.
	4	3.30 p. m.. .	647.1	8.5	646.2	8.5	25.478	25.443	37	Do.
	5	10 a. m.....	654.2	4.5	650.7	4.5	25.687	25.549	17	Thermometer at sunrise 14°; light clouds.
	5	12 m	650.2	4.5	650.6	4.5	25.554	25.570	21	Cloudy.
	5	3.30 p. m....	650.9	5.5	651.5	5.5	25.636	25.663	22	Light clouds; storm of northwest wind.
	6	9.30 a. m....	656.8	2	656.4	2	25.802	25.790	14	Thermometer at sunrise 8°; clear.
	6	12 m	656.8	2	656.4	2	25.822	25.810	18	Clear; strong wind from northwest.
	6	3 p. m.....	658.3	4.5	658.9	4.5	25.928	25.948	19	Clear.
	7	9.30 a. m....	658.8	1	661.4	1	25.885	25.987	18	Thermometer at sunrise 12°; clear.
	7	12 m	658.8	4	661.4	4	25.893	25.995	27	Clear.
	7	3.30 p. m....	659.6	4	660.4	4	25.986	26.018	28	Do.
	9	9 a. m.....	655.6	4.5	654.3	4.5	25.752	25.701	28	Thermometer at sunrise 25°; snow fell during night, depth three inches.
	10	10 a. m.....	655.3	7	655.1	7	25.718	25.714	30	Cloudy, with signs of snow.
	10	12 m	655.6	8	655.2	8	25.751	25.735	35	Clear.
	10	3.30 p. m....	656.1	12	657.1	12	25.817	25.856	34	Light clouds.
	11	9.30 a. m....	652.8	4.5	652	4.5	25.633	25.605	33	Thermometer at sunrise 25°; cloudy, with signs of snow.
	11	1.15 p. m....	651.7	6.5	649.8	6.5	25.626	25.552	34	Light fall of snow.
	12	9.15 a. m....	643.8	5	642.2	5	25.285	25.222	37	Thermometer at sunrise 36°; snow falling very fast.
	12	12 m	643.9	5	642.4	5	25.306	25.247	36	Strong wind from northwest.
	12	3 p. m	643.9	5	642.4	5	25.361	25.302	35	Snow still continues to fall.
	13	9.30 a. m....	643.1	8.5	641.5	8.5	25.243	25.176	44	Cloudy; thermometer at sunrise 34°.
	13	3 p. m.....	639.9	10	638.2	10	25.184	25.117	48	Cloudy; strong wind from northwest.
	14	9 a. m.....	637.2	9	637	9	25.012	25.004	45	Thermometer at sunrise 45°; lowering clouds; strong wind from southwest.
	14	12.45 p. m...	624	11	635.7	11	24.922	24.965	40	Hail storm; wind from northwest.
	14	3.30 p. m....	635.6	10	636.4	10	25.022	25.053	31	Snow falling very fast.
	15	9 a. m.....	639.5	6	639.4	4	25.114	25.118	28	Thermometer at sunrise 22°; cloudy; snow eight to ten inches deep.
	15	12 m	640.3	8	641	8	25.152	25.180	31	Cloudy.
	16	9 a. m.....	643.2	3	643.2	3	25.271	25.271	20	Thermometer at sunrise 19°; light clouds.
	16	12.20 p. m...	643.3	5	643.8	5	25.288	25.307	26	Light clouds.
	16	3 p. m.....	642.9	5	643.2	5	25.322	25.334	26	Cloudy; slight fall of snow during the night.
	17	9.15 a. m....	643.4	1	643.8	1	25.285	25.301	26	Thermometer at sunrise 24°; cloudy.
	17	12 m	643.2	4	642.4	4	25.283	25.251	34	Cloudy; slight fall of snow during the night.
	18	9.15 a. m....	647.2	1	647.7	1	25.435	25.450	16	Thermometer at sunrise 12°.
	18	12.30 p m...	645.8	1.5	645	1.5	25.403	25.371	29	Cloudy.
	18	3 p. m.....	644.7	5	643.2	5	25.393	25.334	24	Do.
	19	9.15 a. m....	636.7	— 1	637.4	— 1	25.029	25.057	19	Thermometer at sunrise 19°; snow falling very fast; wind northwest.
	19	12.25 p. m...	636.8	0	637.4	0	25.056	25.080	15	Snow ceased to fall; strong wind from northwest.
	19	3.30 p. m....	639.1	1	639.4	1	25.195	25.207	13	Cloudy, with signs of snow.
	20	9 a. m.....	653.3	— 6	654.6	— 6	25.708	25.760	0	Thermometer at sunrise 2°; cloudy.
	20	12.25 p. m...	654.9	— 1	656.7	— 1	25.777	25.848	0	Light clouds in northwest.
	20	3 p. m.....	655.6	0	656.8	0	25.842	25.849	0	Clear.
	21	9.30 a. m....	654.9	— 7	654.9	— 7	25.770	25.770	— 4	Thermometer at sunrise — 14°; light clouds in northwest.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1854.						*Inches.*	*Inches.*		
Great Salt Lake City..	Jan. 21	12 m	654.9	— 3	653.6	— 3	25.775	25.723	5	Clear; wind from northwest.
	21	3 p. m.....	653.6	— 3	652.2	— 3	25.778	25.719	8	Light clouds.
	22	9.45 a. m....	658.6	— 2	658.5	— 2	25.881	25.890	8	Thermometer at sunrise 11°; clear.
	22	3 p. m.....	659.2	.....	660.1	.....	25.983	26.019	12	Clear.
	23	9.15 a. m....	658.1	— 3	657.8	— 3	25.880	25.872	16	Thermometer at sunrise 8°; light clouds in northeast.
	23	12 m	658.4	3	657.3	3	25.881	25.842	27	Light clouds.
	23	3.30 p. m....	657.9	3	656.2	— 3	25.923	25.884	21	Cloudy.
	24	9 a. m.....	651.7	— 1	654.5	— 1	25.665	25.736	26	Thermometer at sunrise 18°; cloudy.
	24	12.20 p. m...	649.9	— 0.5	648.7	— 0.5	25.591	25.543	27	Cloudy, with signs of snow.
	25	9.30 a. m....	646.2	3.5	648	3.5	25.381	25.451	39	Thermometer at sunrise 37°; snow fell during the night.
	25	12 m	646.2	3.5	645	3.5	25.401	25.353	38	Snow falling.
	25	3.30 p. m....	647.1	3.5	648.3	3.5	25.498	25.545	33	Cloudy.
	26	9.30 a. m....	655.9	3	656.4	3	25.763	25.782	14	Thermometer at sunrise 11°; clear.
	26	12.15 p. m...	657.2	5.5	657.3	5.5	25.831	25.835	28	Clear.
	27	10 a. m.....	660.7	3	660.5	3	25.947	25.939	22	Thermometer at sunrise 6°; clear.
	27	12 m	660.7	5	660.5	5	25.964	25.956	30	Clear.
	28	9.15 a. m....	660.6	3	659.7	3	25.951	25.915	36	Cloudy, with signs of snow.
	28	12 m	660.7	7	659.8	7	25.956	25 920	37	Clear.
	29	9 a. m.....	660.7	5.5	659.4	5.5	25.945	25.897	37	Cloudy, with signs of snow.
	31	9 a. m.....	659.6	3	658.4	3	25.913	25.866	24	Heavy fog; thermometer at sunrise 15°.
	Feb. 1	9 a. m.....	644.9	3	647.7	3	25.338	25.445	24	Frost; thermometer at sunrise 18°; cloudy.
	1	12 m	646.9	2	647.7	2	25.357	25.464	31	Cloudy.
	2	9 a. m.....	655.3	2.5	654.9	2.5	25.738	25.728	18	Clear; thermometer at sunrise 14°.
	2	12 m	655.8	5	655.8	5	25.771	25.771	28	Clear.
	2	4 p. m.....	655.6	6	655.6	6	25.829	25.829	26	Do.
	3	9 a. m.....	654.3	2.5	653.2	2.5	25.708	25.665	27	Cloudy; thermometer at sunrise 18°.
	3	12.25 p. m...	654.7	6.5	653.8	6.5	25.730	25.694	34	Clear.
	4	9 a. m.....	653.8	5	652.8	5	25.677	25.638	38	Cloudy; thermometer at sunrise 28°.
	5	10 a. m.....	653.9	6.5	653.5	6.5	25.663	25.651	44	Cloudy.
	5	3 p. m.....	653.2	7.5	650.7	7.5	25.715	25.673	38	Cloudy; at 12 m. slight fall of rain.
	6	9 a. m.....	652.7	8.5	651.8	8.5	25.622	25.582	40	Clear in northwest; sky partially overcast.
	6	11 a. m.....	653.1	8	652.5	8	25.623	25.599	50	Cloudy.
	6	3 p. m.....	653.1	8	652.5	8	25.708	25.684	44	Do.
	7	9 a. m.....	653.2	7	652.3	7	25.645	25.610	40	Foggy.
	7	1 p. m.....	653.3	7.5	652.6	7.5	25.684	25.653	45	Cloudy, with signs of rain.
	8	9 a. m.....	654.6	6	655	6	25.705	25.794	34	Clear.
	8	12 m.....	654.6	10.5	655	10.5	25.700	25.720	47	Do.
	9	9 a. m.....	652.6	7	651.9	7	25.622	25.594	35	Do.
	9	12.30 p. m...	652.8	10	651.8	10	25.643	25.603	48	Do.
	10	9 a. m.....	647.9	8	647.1	8	25.433	25.405	46	Cloudy; light breeze from southeast.
	10	12.15 p. m...	646.8	8.5	645.9	8.5	25.410	25.374	50	Cloudy; light breeze from southeast.
	10	3 p. m.....	646.5	8.5	645.7	8.5	25.448	25.416	46	Slight fall of rain.
	11	9 a. m.....	643	8	641.9	8	25.244	25.201	44	Stormy.
	11	12.30 p. m...	642.1	9	640.4	9	25.230	25.162	49	2.15 p. m. hail, with strong wind from southwest; 3 p. m. snow.
	11	3 p. m	642	9	640.3	9	25.271	25.204	37	Snow.
	12	9 a. m.....	643	5.5	644.2	5.5	25.275	25.299	34	Cloudy; light breeze from northwest.
	12	12 m.....	643.4	5.5	643.3	5.5	25.282	25.279	35	Snow, falling very fast.
	12	3 p. m.....	643.4	5.5	643.3	5.5	25.338	25.334	32	Cloudy.
	13	9 a. m.....	643.1	2	643.3	2	25.271	25.279	28	Snowing very fast; strong wind from northwest.
	13	12 m.....	645	4	645.2	4	25.353	25.361	32	Cloudy; snow ceased.
	13	3 p. m.....	646.5	7	647	7	25.456	25.475	35	Broken clouds; strong wind from northwest.
	14	9 a. m.....	652.2	2	652.2	2	25.630	25.630	25	Cloudy, with signs of snow; thermometer at sunrise 16°.
	14	12 m.....	652.3	4.5	652.4	5	25.637	25.637	40	Slight fall of snow.
	15	9 a. m.....	653.2	4	652.1	4	25.661	25.618	29	Cloudy; thermometer at sunrise 20°.
	15	12 m...	653.2	3	652.1	3	25.680	25.637	44	Cloudy.
	15	3 p. m.....	653	3	652.1	3	25.727	25.692	38	Slight fall of snow.
	16	9 a. m.....	650.1	2.5	649.6	2.5	25.543	25.523	38	Thermometer at sunrise 32°; cloudy.
	16	12 m.....	650.1	5	649.6	5	25.550	25.527	44	Few light clouds visible.
	16	3 p. m.....	650.2	5	649.8	5	25.609	25.589	40	Cloudy in the north and west.
	17	9 a. m.....	649.9	4	650	4	25.527	25.535	33	Clear; thermometer at sunrise 28°.
	17	12 m.....	650.4	8	650.2	8	25.546	25.538	40	Clear; snow melting rapidly.
	17	3 p. m.....	650.4	10	650.2	10	25.593	25.586	40	Clear.
	18	Sunrise	649.8	3	650.1	3	25.547	25.563	24	Clear and calm.
	18	10 a. m.....	650.1	7.5	650.5	7.5	25.513	25.529	38	Clear and pleasant.
	18	12 m.....	650.1	7.5	650.5	7.5	25.538	25.554	36	Clear, with light breezes from the north.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer No. 551.	Air temperature, (F.)	Remarks.
	1854.						*Inches.*	*Inches.*		
Great Salt Lake City..	Feb. 18	3 p. m.....	650.5	10	650.6	10	25.597	25.601	35	Clear.
	19	9 a. m.....	650.8	5.5	651.4	5.5	25.555	25.622	34	Clear and pleasant.
	19	12 m.....	650.8	9	651.4	9	25.558	25.582	40	Clear.
	19	3 p. m.....	650.8	11	650.9	11	25.605	25.609	42	Do.
	20	Sunrise.....	650.3	4.5	651	4.5	25.563	25.591	25	A few light clouds in northwest.
	20	9 a. m.....	650.3	6	651	6	25.535	25.567	38	Light clouds.
	20	12 m.....	650.3	7	651	7	25.546	25.578	38	Cloudy; at 2 p. m. slight fall of snow.
	20	3 p. m.	650	7.5	649.8	7.5	25.589	25.578	40	Broken clouds, with signs of snow.
	21	9 a. m.....	651.1	5	651.8	5	25.574	25.698	38	Broken clouds; snow fell during the night; depth one inch.
	21	12 m.....	652.7	9	652.7	9	25.633	25.633	41	Light clouds.
	21	3.30 p. m....	652.9	9	652.8	9	25.703	25.699	41	Clear; light breeze from northwest.
	22	9 a. m.....	656.1	6	653.4	6	25.768	25.736	34	Clear; light breeze from south.
	22	12 m.....	656.3	9	656.3	9	25.775	25.775	40	Clear.
	22	3 p. m.....	656.3	10	656.3	10	25.826	25.826	46	Light clouds.
	23	9 a. m.....	653	6.5	651.7	6.5	25.642	25.630	45	Cloudy.
	23	12 m.....	652.4	6.5	651.2	6.5	25.633	25.586	46	Cloudy, with signs of rain.
	23	3 p. m.....	651.8	6	651	6	25.664	25.637	39	Rain; 4.20 p. m. snow commenced to fall.
	24	9 a. m.....	653	5	652.5	5	25.649	25.626	37	Thermometer at sunrise 37°.
	24	12 m.....	653.1	6.5	653.8	6.5	25.660	25.684	44	Slight fall of snow.
	24	3 p. m.....	653.1	7	653.8	7	25.715	25.739	40	Light clouds.
	25	9 a. m.....	653.2	5	653.7	5	25.657	25.673	34	Clear.
	25	12 m.....	653.3	8	653.8	8	25.660	25.680	40	Clear and pleasant.
	25	3 p. m.....	652.7	10	651.2	10	25.684	25.625	40	Cloudy, with signs of snow.
	26	9 a. m	648.9	5	648.1	5	25.484	25.456	34	Snow falling very fast; strong wind from northwest.
	26	12.30 p. m...	649.3	5	648.6	5	25.525	25.497	35	Snow falling very fast; strong wind from northwest.
	26	3 p. m.....	649.9	8	649.7	8	25.582	25.574	40	Cloudy.
	27	9 a. m.....	649.9	3	649.7	3	25.531	25.523	37	Do.
	27	12 m.....	650.4	8	651.4	8	25.546	25.586	46	Light clouds.
	27	3 p. m.....	650.4	8.5	651.2	8.5	25.601	25.633	47	Cloudy in the northwest.
	28	9 a. m.....	643.9	6	643.1	6	25.287	25.256	47	Light fall of snow.
	28	12 m.....	644.2	8	643.6	8	25.306	25.286	46	Cloudy in the northwest; strong wind from southeast.
	28	3 p. m.....	644.2	10	643.6	10	25.353	25.326	46	Slight fall of snow.
	March 1	9 a. m.....	646.2	4	647.8	4	25.386	25.445	37	Cloudy, with signs of snow.
	1	12 m.....	646.8	5	648.9	5	25.420	25.499	42	Snow falling fast; strong wind from northwest.
	2	9 a. m.....	651.2	4	651.4	4	25.582	25.586	33	Light clouds.
	2	12 m.....	651.6	7	651.4	7	25.601	25.589	43	Do.
	2	3 p. m.....	651.6	7	651.4	7	25.656	25.644	44	Cloudy.
	3	9 a. m.....	651.2	4.5	651.8	4.5	25.578	25.698	32	Clear; snow fell during the night to the depth of an inch.
	3	12 m.....	651.6	8	652.3	8	25.593	25.621	39	Clear.
	4	9 a. m.....	648.7	5	647.7	5	25.476	25.437	46	Cloudy; light wind from south.
	4	12 m	648.1	7	647.2	7	25.464	25.428	48	Cloudy, with strong wind from south.
	4	3 p. m.....	646.8	6	646.5	6	25.471	25.460	47	Cloudy, with signs of snow; 4.30 p. m. snowing heavily.
	5	9 a. m.....	647.7	6	648.3	6	25.433	25.456	44	Slight fall of snow; strong wind from northwest.
	5	12 m	647.7	7	648.3	7	25.444	25.467	49	Snow falling fast.
	5	3 p. m.....	647.9	8	648.3	8	25.503	25.519	42	Cloudy.
	6	9 a. m.....	647.6	5.5	648.1	5.5	25.433	25.452	42	Snow.
	6	12.20 p. m...	647.6	8	648.1	8	25.441	25.465	56	Cloudy.
	6	3 p. m.....	647.5	8	648	8	25.487	25.511	54	Fine snow.
	7	9 a. m.....	648	5.5	650.4	5.5	25.449	25.472	48	Cloudy.
	7	12 m	649.2	8.5	650.4	8.5	25.499	25.546	42	Clear.
	7	3 p. m.....	649.7	11	647.7	11	25.562	25.589	40	Do.
	8	9 a. m.....	648.2	6	647.7	6	25.456	25.433	43	Cloudy.
	8	12 m	648.1	8	651.1	8	25.460	25.440	46	Do.
	9	9 a. m.....	650.6	5	643.8	5	25.551	25.574	38	Clear and pleasant.
	12	9 a. m.....	644.1	7	646.6	7	25.291	25.279	45	Do.
	13	9 a. m.....	645	5.5	646.9	5.5	25.331	25.393	34	Snow.
	13	12 m	645.3	9	649.7	9	25.346	25.408	49	Cloudy; three inches of snow on the ground.
	15	12 m	648.3	12.5	650.4	12.5	25.448	25.499	54	Clear.
	16	9 a. m.....	649.3	10.5	651.1	10.5	25.476	25.523	50	Do.
	16	12 m	649.6	13.5	649.9	13.5	25.491	25.554	64	Light clouds.
	17	9 a. m.....	651.5	11.5	648.6	12	25.559	25.496	49	Do.
	20	9 a. m.....	648.1	11	648.8	11	25.429	25.456	50	Rain, accompanied by thunder and lightning.
	20	12 m	648.6	12	648.3	12	25.460	25.448	44	Stormy.
	21	9 a. m.....	652.4	11	652 2	11	25.598	25.590	49	Cloudy.
	21	12 m	654.7	13.8	653.5	14	25.692	25.645	57	Rain.
	21	3 p. m.	652.3	16.5	653.6	17	25.641	25.688	54	Clear.
	22	9 a. m.....	655.2	8	653.8	8	25.681	25.622	47	Do.
	22	12 m	655.2	13	653.8	13	25.716	25.657	53	Do.
	22	3 p. m.....	655.2	16	653.8	16	25.759	25.700	57	Do.
	23	9 a. m.....	655.3	12	653.6	12	25.708	25.642	52	Do.
	23	12 m	655.2	13.5	653.9	14	25.716	25.657	54	Do.
	24	9 a. m.....	649.8	17	648.6	17	25.538	25.495	59	Light clouds.
	24	12 m	652.6	12	651.4	12	25.602	25.555	49	Light clouds; strong breeze from northwest.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1854.						*Inches.*	*Inches.*		
Great Salt Lake City..	Mar. 24	3 p. m.....	651	14	649.7	14	25.546	25.493	58	Light clouds.
	25	9 a. m.....	649.8	11.5	649.3	11.5	25.492	25.472	49	Do.
	25	12 m	650.2	15	649.6	15	25.511	25.487	57	Do.
	26	9 a. m.....	650 3	11.3	649.5	11.3	25.516	25.484	54	Do.
	26	12 m	650.6	15.5	650	15.5	25.523	25.503	59	Clear.
	27	9 a. m.....	650.4	13	650	12	25.512	25.498	59	Light clouds.
	27	12 m	650.7	16.5	650	16.5	25.523	25.511	68	Do.
	28	12 m	650.6	15.5	650	15.5	25.523	25.503	59	Slight fall of rain.
	28	3 p m.....	651.3	16.6	651	16.7	25.601	25.593	63	Cloudy.
	29	9 a m.....	653.1	14.8	652.6	15	25.622	25.590	58	Light clouds.
	29	12 m	649.3	16.9	648	17	25.467	25.446	6[illegible]	Clear.
	29	3 p. m.....	647	19	648.2	19.5	25.424	25.471	62	Do.
	30	9 a. m.....	649.7	11.5	648.8	11.5	25.488	25.452	39	Snow and rain, with strong wind from northwest.
	30	12 m	649.9	12.5	649.2	12.5	25.507	25.483	35	Snow and rain, with strong wind from northwest.
	30	3 p. m.....	649.9	10	649.2	10	25.574	25.546	36	Cloudy.
April 1		9 a. m.....	659	10.5	658.6	10.5	25.863	25.760	51	Do.
1		12 m	659.6	12.5	659.9	12.5	25.889	25.743	55	Do.
2		9 a. m.....	656.3	11	655.4	11	25.751	25.716	52	Slight fall of rain.
2		12 m	656.1	15	654.5	15.5	25.743	25.676	68	Cloudy.
2		3 p. m.....	654.9	15	653.4	15	25.747	25 692	69	Light clouds.
4		9 a. m.....	.....	.....	654.3	10	.....	25.677	54	Do.
4		12 m	.....	.....	659.1	16.6	.....	25.853	60	Wind from southwest; clear.
4		3 p. m	.....	.....	658.5	19.8	.....	25.839	64	Do do.
5		9 a. m.....	.....	.....	657	16	.....	25.760	62	Light clouds.
5		12 m	.....	.....	655	18.5	.....	25.681	68	Light northwest wind.
5		3 p. m.....	.....	.....	654.4	21	.....	25.701	71	
6		6 a. m.....	.....	.....	648.4	15	.....	25.458	47	Thermometer at sunrise 21°.
6		9 a. m.....	.....	.....	651.4	21	.....	25.634	57	
6		12 m	.....	.....	653.9	16.1	.....	25.649	59	
6		3 p m.....	.....	.....	649	.....	.....	.....	43	
7		Sunrise.....	.....	.....	648.1	11	.....	25.456	42	Thermometer at sunrise 42°.
7		12 m	.....	.....	649.2	11.5	.....	25.472	47	
7		3 p. m.....	.....	.....	646	12	.....	25.361	51	Wind north.
7		Sundown.....	.....	.....	654	13.7	.....	25.723	44	
8		Sunrise.....	.....	.....	648.5	11.6	.....	25.511	35	Clear; thermometer at sunrise 35°.
8		9 a. m.....	.....	.....	651.2	9.5	.....	25.586	41	
8		Noon	.....	.....	648.7	10	.....	25.456	48	Wind northwest.
8		3 p. m.....	.....	.....	648.8	12.7	.....	25.464	49	
8		Sundown.....	.....	.....	653.4	16	.....	25.668	48	Light clouds.
9		Sunrise.....	.....	.....	656.8	15.5	.....	25.901	34	Thermometer at sunrise 40°.
9		9 a. m.....	.....	.....	651.3	9.4	.....	25.590	46	
9		Noon	.....	.....	651.5	10	.....	25.567	56	Clear; wind south.
9		3 p. m.....	.....	.....	647.1	10.8	.....	25 460	53	
9		Sundown.....	.....	.....	647	12.7	.....	25.452	51	
10		Sunrise.....	.....	.....	647.4	9	.....	25.410	39	
10		9 a. m.....	.....	.....	647.5	9.5	.....	25.413	47	
10		Noon.....	.....	.....	649	11	.....	25 483	44	Rained until 11 a. m.
10		3 p. m.....	.....	.....	649.1	15	.....	25.522	52	Wind northwest; clear.
10		Sundown.....	.....	.....	649.6	14.7	.....	25.542	49	Clear; wind southeast.
11		Sunrise.....	.....	.....	649.8	9.5	.....	25.523	41	
11		9 a. m.....	.....	.....	649.6	10	.....	25.492	54	
11		Noon.....	.....	.....	649.9	12.5	.....	25.507	56	Wind northwest.
11		3 p. m.....	.....	.....	647.8	14	.....	25.475	57	Cloudy.
12		9 a. m.....	.....	.....	648.3	9	.....	25.445	44	Thermometer at sunrise 40°.
12		Noon.....	.....	.....	650.8	10	.....	25 554	49	Hail and rain; wind north.
12		3 p. m.....	.....	.....	651.8	10.5	.....	25.644	45	Do do.
12		Sundown.....	.....	.....	646.8	10.6	.....	25.452	47	Rain; wind north.
13		9 a. m.....	.....	.....	655.1	9	.....	25.712	43	Thermometer at sunrise 38°.
13		Noon.....	.....	.....	643	8.5	.....	25.955	51	Clear; wind northwest.
13		3 p. m.....	.....	.....	655.4	14.7	.....	25.771	53	
13		Sundown.....	.....	.....	654.5	13	.....	25.743	49	
14		9 a. m.....	.....	.....	656.4	11	.....	25.756	49	Thermometer at sunrise 44°.
14		Noon.....	.....	.....	655.6	13	.....	25.731	56	
14		3 p. m.	.....	.....	656.4	16	.....	25.806	59	Clear; wind northwest.
14		Sundown.....	.....	.....	654.8	16	.....	25.739	57	
15		9 a. m.....	.....	.....	655.7	12	.....	25.794	54	Thermometer at sunrise 50°; clear; wind northwest.
15		Noon.....	.....	.....	652.8	15.5	.....	25.609	64	
15		3 p. m.....	.....	.....	653.5	18	.....	25.680	66	
15		Sundown.....	.....	.....	659.1	17.7	.....	25.904	63	
16		9 a. m.....	.....	.....	652.8	14	.....	25.598	54	Thermometer at sunrise 49°; wind west; unsteady all day.
16		Noon.....	.....	.....	651.9	17.7	.....	25.562	69	Light clouds.
16		3 p. m.....	.....	.....	650.7	20	.....	25.562	71	
16		Sundown.....	.....	.....	650.2	20.4	.....	25.542	69	
17		9 a. m.....	.....	.....	650.1	15	.....	25.493	60	Thermometer at sunrise 50°; wind south; clear.
17		Noon.....	.....	.....	650.6	20	.....	25.503	73	
17		3 p. m.....	.....	.....	650.4	22.5	.....	25.502	74	
17		Sundown.....	.....	.....	649.4	20.8	.....	25.511	69	Wind northeast.
18		9 a. m.....	.....	.....	6.9	17	.....	25.441	62	Thermometer at sunrise 51°; light clouds, wind southeast.
18		Noon.....	.....	.....	648.7	23	.....	25.430	75	Southerly wind.
18		3 p. m.....	.....	.....	646.8	25.5	.....	25.303	79	Light clouds
18		6 p. m.....	.....	.....	646.2	20.7	.....	25.385	69	Cloudy.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1854.						*Inches.*	*Inches.*		
Great Salt Lake City..	April 19	9 a. m.....	.....	.....	647.7	15	.....	25.397	48	Rain during the night; thermometer at sunrise 51°.
	19	Noon.....	.....	.....	648	15	.....	25.424	52	At 7 a. m. rain, wind west; at 9 a. m., south wind; noon clear.
	19	3 p. m.....	.....	.....	647.1	19.8	.....	25.428	57	Wind southeast.
	19	Sundown....	.....	.....	647.5	17	.....	25.452	54	Light clouds.
	20	Sunrise.....	.....	.....	646.7	13.7	.....	25.399	47	Thermometer at sunrise 47°; rain until 7 a. m.
	20	9 a. m.....	.....	.....	646.9	14	.....	25.374	50	Rain from 10 to 12.
	20	Noon.....	.....	.....	647.1	14.8	.....	25.393	46	Clear.
	20	3 p. m.....	.....	.....	647.6	18.5	.....	25.448	59	Thunder; cloudy in the southwest.
	20	6.15 p. m....	.....	.....	646.1	16	.....	25.404	55	
	22	Sunrise	.....	.....	644	10	.....	25.306	42	Northwest wind; heavy clouds in the east.
	22	9 a. m.....	.....	.....	643.9	11.5	.....	25.296	47	Cloudy.
	22	Noon.....	.....	.....	643.9	12.7	.....	25.292	49	Commenced to rain at 10 a. m.
	22	3 p. m.....	.....	.....	643.6	11	.....	25.286	43	Rain.
	22	6.20 p. m....	.....	.....	644.2	11	.....	25.310	44	Rain ceased at 4½ p. m.; wind northeast.
	23	Sunrise.....	.....	.....	642.8	9	.....	25.263	41	Cloudy in the east; heavy rain during the night.
	23	9 a. m.....	.....	.....	642.5	10.5	.....	25.246	50	Northwest wind and flying clouds.
	23	Noon.....	.....	.....	642	11.5	.....	25.222	57	Northwest wind and flying clouds.
	23	3 p. m.....	.....	.....	640.4	14.5	.....	25.147	56	High wind.
	23	Sundown....	642	13	640.9	13	25.216	25.173	54	Rain.
	24	Sunrise.....	643.1	11	642.7	10.5	25.266	25.254	44	Heavy rain during the night.
	24	9 a. m.....	647.7	11	645.9	11.5	25.447	25.375	46	Rain; wind northwest.
	24	Noon.....	645.2	12	646.1	12	25.345	25.380	49	Heavy clouds.
	24	3 p. m.....	645.3	14	647 8	13.5	25.341	25.441	54	Northeast wind; clearing up.
	24	Sundown....	645.4	15.4	646.7	15	25.339	25.391	53	Northeast wind; clear.
	25	Sunrise.....	644.8	10	644.6	10.5	25.337	25.328	41	Wind south.
	25	9 a. m.....	643.5	13	644.1	12.8	25.275	25.300	57	High wind from the south, with heavy clouds.
	25	Noon.....	644.8	13.4	645.5	13	25.323	25.354	56	High wind from the south, with heavy clouds.
	25	3 p. m.....	643.6	16	644.3	15.6	25.266	25.295	59	Southerly wind; light clouds.
	25	4.30 p. m....	644.1	14.7	644.8	14.0	25.291	25.322	53	Heavy squall of wind from southwest, with rain.
	25	6.20 p. m....	644.6	10.5	645.1	10	25.307	25.249	43	Wind changed to northwest; cold rain.
	26	Sunrise.....	648.8	9.5	649.2	10	25.507	25.510	37	Rain all night; snow in the eastern mountains.
	26	9 a. m.....	649.9	10	650.7	10.5	25.538	25.567	51	Wind south, with heavy clouds.
	26	Noon.....	650.9	12.6	651.4	12.8	25.567	25.586	51	Wind northwest; heavy squall of rain; duration 20 minutes.
	26	3 p. m.....	651.6	14.9	651.7	14.9	25.585	25.589	52	Wind northwest; heavy clouds.
	26	Sundown....	652.7	14.5	651.7	14.6	25.630	25.591	49	Do. light clouds.
	27	Sunrise.....	652.9	9	651.5	9.5	25.659	25.603	36	Wind northeast; light clouds; frost during the night.
	27	9 a. m.....	653.2	12	653.7	12	25.660	25.680	50	Wind southwest; clear.
	27	Noon	652.4	14.9	653.5	14	25.615	25.672	55	Wind northwest; clear.
	27	3 p. m.....	652.4	16	653.4	15.8	25.612	25.652	60	Wind northwest; cloudy.
	27	6.30 p. m....	653	14	652.5	14.4	25.644	25.622	54	Wind west; cloudy.
	28	Sunrise.....	650.9	10.5	652.5	11	25.575	26.636	43	Wind northeast; light clouds.
	28	9 a. m.....	652,2	14.9	651.9	14	25.609	25.601	61	Wind northwest; cloudy.
	28	Noon	651.7	17	651.4	16.4	25.581	25.571	68	Do do.
	28	3 p. m.....	650.7	19.2	650.6	18.8	25.531	25.530	68	Wind northwest; hazy.
	28	Sundown	650.6	17	649.3	17	25.537	25.486	61	Wind west; hazy.
	29	Sunrise.....	648.8	14.1	648	15	25.479	25.442	55	Wind northeast; cloudy in the west.
	29	9 a. m.....	648.4	17.5	648.6	17	25.448	25.458	69	Wind northeast; hazy.
	29	Noon	647.9	20	646.7	19.5	25.418	25.373	78	Wind southeast; light clouds.
	29	3 p. m.....	645.6	20.3	643.7	19.8	25.327	25.254	73	Wind southeast; cloudy.
	29	Sundown...	644.5	17	642.8	17.8	25.297	25.227	65	Wind northeast; heavy clouds.
	30	Sunrise	642.4	16	640.5	16	25.219	25.145	59	Do do.
	30	9 a. m.....	643.3	17.2	642.9	17	25.249	25.235	62.5	Wind southeast; heavy clouds.
	30	Noon	642.2	18.9	644.1	18.5	25.200	25.276	67	Wind south; heavy clouds in the west.
	30	3 p. m.....	642.5	19.5	645.4	19	25.206	25.325	65	Wind southwest; heavy clouds.
	30	Sundown....	643.9	17	644.8	17	25.273	25.309	59	Wind northwest; heavy clouds.
May	1	Sunrise.....	644.7	15.4	646.6	15	25.311	25.387	47	Wind southeast; heavy clouds.
	1	9.30 a. m....	645.5	16	647	16	25.341	25.400	59	Wind northwest; heavy clouds.
	1	Noon	646.1	19	648.6	18.5	25.352	25.453	66	Wind southeast; heavy clouds.
	1	3 p. m.....	645.5	18	648.3	18	25.332	25 442	62.5	Wind northwest; heavy clouds.
	1	6.30 p. m....	646.5	16.8	647.9	17	25.377	25.431	53	Wind northeast; cloudy.
	2	Sunrise.....	647.3	15	647.9	14.6	25.415	25.441	47	Cloudy; westerly wind.
	2	9 a. m.....	647.3	17	649.6	16.1	25.408	25.501	62	Cloudy; wind northwest.
	2	Noon.....	647.2	19	650.6	18.9	25.396	25.490	68	Do do.
	2	3 p. m.....	647.2	21	649.7	20.9	25.388	25.520	68.5	Light clouds in northwest.
	2	Sundown....	648	19.3	649.1	19	25.426	25.471	61.5	Clear; wind northwest.
	3	Sunrise.....	648	15.9	649.3	15.9	25.439	25.490	52	Clear; easterly wind.
	3	9 a. m.....	648.1	17	649.8	16.1	25.455	25.510	62	Clear; westerly wind.
	3	Noon.....	647.3	19	650	18.9	25.400	25.506	67	Clear; northwest wind.
	3	3 p. m.	647.5	23.2	649.4	22.5	25.390	25.467	71	Do do.
	3	6.30 p. m....	648.1	21	649.1	21	25.422	25.462	66.5	Do do.
	4	Sunrise.....	648.7	16.5	649.9	16.8	25.465	25.510	50	Clear; easterly wind.

II.—*Meteorological Observations at Great Salt Lake City*—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
	1854.						*Inches.*	*Inches.*		
Great Salt Lake City..	May 4	9 a. m.....	648.5	18.9	650	18.5	25.447	25.508	65	Clear; westerly wind.
	4	Noon.....	648.6	21	649.6	20.3	25.442	25.484	71	Do.
	4	3 p. m.....	648.2	23.5	648.6	23	25.416	25.446	74	Do.
	4	Sundown....	648.5	22.3	647.6	22	25.433	25.398	68.5	Clear; north wind.

The altitude of the place of observation in Great Salt Lake City, as deduced from the mean of all the foregoing observations, is 4,351 feet above the sea.

III.—*Summary of meteorological observations at Great Salt Lake City in* 1853 *and* 1854, *in mean results at each observed hour for the several months; barometric readings corrected for temperature.*

	Barometer No. 496.				Barometer No. 551.				Mean of both barometers.	Air temperature.				Remarks.
	9 a. m.	12 m.	3 p. m.	Month.	9 a. m.	12 m.	3 p. m.	Month.		9 a. m.	12 m.	3 p. m.	Month.	
										°	°	°	°	
December, 1853.	25.673	25.664	25.665	25.667	25.672	25.678	25.656	25.669	25.668	36.57	42.90	45.10	41.52	30 observations at 9 a. m.; 22 at 12 m.; 19 at 3 p. m.
January, 1854 ..	25.624	25.592	25.558	25.591	25.613	25.584	25.547	25.581	25.586	24.20	28.35	24.43	25.66	26 observations at 9 a. m.; 21 at 12 m.; 17 at 3 p. m.
February, 1854..	25.593	25.585	25.570	25.583	25.592	25.581	25.558	25.577	25.580	35.46	41.12	39.60	38.73	28 observations at 9 a. m.; 26 at 12 m.; 21 at 3 p. m.
March, 1854.....	25.543	25.542	25.535	25.540	25.543	25.542	25.535	25.540	25.540	40.50	50.80	50.60	47.30	23 observations at 9 a. m.; 22 at 12 m.; 11 at 3 p. m.
April, 1854.....	25.501	25.460	25.379	25.447	25.574	25.545	25.531	25.550	25.550	52.40	58	59.80	56.73	Observations of barometer 551, and of temperature full for the month. Barometer 496 observed 9 days only.
May, 1854.....	25.453	25.422	25.351	25.409	25.519	25.508	25.439	25.489	25.449	62	68	68.80	66.30	Observations for the first four days only.

IV.—*Barometric means for the months observed at Great Salt Lake City,* 1853–'54, *from all the observations, including those at irregular hours, and corrected in detail for horary variation of pressure.*

	Barometer No. 496.	Barometer No. 551.	Mean of both barometers.	Remarks.
December, 1853.....	25.651	25.651	25.651	The mean of the last column is used for the determination of the altitude of Salt Lake City, 25.573, with a mean air temperature, for this period of five months, of 45° F.
January, 1854.....	25.581	25.577	25.579	
February, 1854.....	25.569	25.565	25.567	
March, 1854	25.513	25.520	25.517	Altitude 4,351 feet.
April, 1854.....	.....	25.552	25.552	

V.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt Lake City to Green River—April*, 1854.

Station.	Date.	Hour.	Distance from Great Salt Lake City.	Barometric reading. (Bar. No. 495.)	Attached thermometer, (C.)	Air thermometer.	Corrected barometer.	Barometric means.	Altitude above the sea.
	1854.								
Session Settlement	April 4	5 p. m.	10.50	661.4	18	65	26.011	.....	4183.2
	4	Sunset	.....	661	13	56	25.991		
	5	Sunrise	.....	658.8	7	45	25.903		
	5	6 a. m.	.....	658.4	8.5	49	25.879		
	5	7.15 a. m.	.....	658.9	11	53	25.867	25.930	
On hill, en route	5	1 p. m.	.....	645	26.5	76	25.283		
Weber river, north side	5	1.45 p. m.	29	653.6	25	76	25.434	.....	4430.1
Camp 2, Weber river	5	6 p. m.	36.80	643.4	15	60	25.302	.....	4842
	5	6.30 p. m.	.....	643.5	12	54	25.313		
	6	Sunrise	.....	638.2	0.2	35	25.115		
	6	6.30 a. m.	.....	638	4.5	40	25.086		
On march, Sheep rock	6	7.15 a. m.	.....	638.1	7.5	45	25.069	25.177	
Camp 3, Dry creek	6	12.15 p. m.	49	636.1	17.5	64	24.953	.....	5189.5
	6	4.30 p. m.	57.50	625.3	8	48	24.634	.....	5419.1
	7	6.10 a. m.	.....	625	2.5	36	24.585		
	7	7 a. m.	.....	625	2.5	36	24.575		
	7	7.30 a. m.	.....	624.9	2.5	36	24.506	24.590	
	7	9.30 a. m.	.....	624.3	7	49	24.507		
Camp 4, White Clay creek	7	3.30 p. m.	64	616	6.5	47	24.262	.....	5692.1
	7	4 p. m.	.....	615.9	5	42	24.274		
	7	5 p. m.	.....	615.9	3	39	24.287		
	7	6 p. m.	.....	615.3	2	36	24.247		
	7	7 p. m.	.....	615.3	1	33	24.241		
	8	5 a. m.	.....	618.3	—2.5	28	24.355		
	8	5.30 a. m.	.....	618 3	—2.5	27	24.352		
	8	6 a. m.	.....	619.6	1	29	24.483		
On hill, en route	8	7 a. m.	.....	619.8	3	32	24.370	24.308	
Camp 5, near divide of the waters of Bear and Weber river, side of mountain.	8	12.30 a. m.	77.25	596.6	3	37	23.450	.....	6562.1
	8	4.40 p. m.	87.40	585.7	0	32	23.119		
	8	5 p. m.	.....	585.7	0	32	23.121		
	8	6 p. m.	.....	585.5	—4	23	23.101		
	8	6.30 p. m.	.....	585.2	—4.5	21	23.096		
	9	Sunrise	.....	583.2	—9.5	10	22.991		
	9	5.30 a. m.	.....	582.8	—9.5	11	22.988		
	9	6 a. m.	.....	582.8	—9.5	13	22.986		
	9	7 a. m.	.....	584.3	—4	20	23.012	23.052	
Divide	9	9 a. m.	90.00	573.3	7	37	22.519	.....	7749.7
Divide	9	11 a. m.	91.50	577.5	4.5	40	22.762	.....	7490.8
Bear river valley	9	1 p. m.	96.20	575	5	41	22.614	.....	7551.7
Camp 6, Sulphur creek	9	4 p. m.	104.40	576.1	2	40	22.723	.....	7494.5
	9	5 p. m.	.....	575.2	0	32	22.688		
	9	6.30 p. m.	.....	574.8	—2	28	22.663		
	10	5.30 a. m.	.....	572.9	—3	25	22.556		
	10	6 a. m.	.....	573.3	—1.5	29	22.572		
	10	6.30 a. m.	.....	572.4	1.5	37	22.507		
Divide of Bear and Muddy	10	7 a. m.	.....	572.1	3.5	42	22.500	22.601	
Camp 7, Muddy river	10	10.30 a. m.	109.60	561.2	3	37	22.034	.....	8133.3
	10	2.30 p. m.	115.60	570.7	4	36	22.476	.....	7779.1
	10	3.30 p. m.	.....	569.8	3	34	22.459		
	10	4.30 p. m.	.....	569.3	1.5	33	22.457		
	10	5 p. m.	.....	569.3	1.5	33	22.460		
	10	6 p. m.	.....	569.3	—0.5	32	22.445		
	11	5 a. m.	.....	570.3	—2.5	26	22.464		
	11	5.30 a. m.	.....	570.3	—2.5	27	22.461		
Divide of Muddy and Black's forks	11	6 a. m.	.....	570	—1.5	29	22.435	22.445	
Black's fork	11	8 a. m.	120.60	559.4	5.5	41	21.978	.....	8373.9
Smith's fork, camp 8	11	9.40 a. m.	124.60	570.9	6	46	22.406	.....	7880.5
	11	3.30 p. m.	.....	580.9	7.5	49	22.877		
	11	4 p. m.	.....	580.9	7	47	22.885		
	11	4.30 p. m.	.....	580.9	7	47	22.887		
	11	5 p. m.	.....	580.4	5.5	43	22.885		
	12	5.45 a. m.	.....	580.5	—0.5	32	22.850		
Cottonwood	12	6.45 a. m.	.....	580.5	0	32	22.839	22.870	
Camp 9, Henry's fork	12	1 p. m.	.....	584.2	8	51	22.965	.....	7263.9
	12	7 p. m.	156.30	587.6	0.5	34	23.145	.....	7136.6
	13	5.30 a. m.	.....	585.8	—0.4	24	23.065		
	13	6 a. m.	.....	585.8	—0.3	27	23.061		
	13	6.30 p. m.	.....	587.3	2	34	23.136		
Mountain peak, overlooking country; (end of eastern course.)	14	5.30 a. m.	.....	587.8	—0.5	20	23.142	23.110	
Dry Timber creek; (return trip)	13	11 a. m.	169.50	571.9	7	34	22.435	.....	8067.8
	13	1.30 p. m.	163.10	594.4	13	50	23.355	.....	7024 7
			Distance f'm Green river.						
Top of pass, between Smith's & Henry's forks	14	8 a. m.	31.50	582.9	6	40	22.890	.....	7529.6
Camp 10, Smith's fork	14	5.30 p. m.	54	594.4	13	50	23.395	.....	6970.8
	14	6.30 p. m.	.....	594.1	7.5	44	23.385		
	14	6.46 p. m.	.....	593.9	5.5	41	23.382		
	15	6.40 a. m.	.....	595.7	7.5	35	23.410		
	15	7 a. m.	.....	595.9	14	39	23.390	23.392	
Divide of Muddy and Black's fork	15	11 a. m.	65	584.8	15	56	22.915	.....	7446.9
Camp 11, Muddy creek	15	1.05 p. m.	69.75	596.8	22.5	76	23.415	.....	6984.2
	15	3 p. m.	.....	596.8	22	69	23.450		
	15	5 p. m.	.....	595.4	21	61	23.417		
	16	Sunrise	.....	592.6	—6	22	23.238		

V.—*Meteorological Observations, and Table of Altitudes and Distances*—Continued.

Station.	Date.	Hour.	Distance from Green river.	Barometric reading. (Bar. No. 496.)	Attached thermometer, (C.)	Air thermometer.	Corrected barometer.	Barometric means.	Altitude above the sea.
	1854.								
Camp 11, Muddy creek	April 16	6.30 a. m.	.....	593.3	7	43	23.317	23.385	
Camp 12, Bear river	16	3 p. m.	94.25	586.5	17	66	23.062	28.444	7195.6
	16	4.30 p. m.	.....	586.3	16.5	63	23.067		
	16	5.30 p. m.	.....	585.7	14	58	23.050		
	16	6.30 p. m.	.....	584.7	5.5	42	23.025		
	17	5.30 a. m.	.....	585.1	0	31	23.030		
	17	5.58 a. m.	.....	585.2	2.5	36	23.025	23.043	
Near upper camp, on White Clay creek	17	10 a. m.	105.25	592.3	21	69	23.195	.....	7009.2
Camp 13, White Clay creek	17	1.30 p. m.	114.45	601.2	22.5	75	23.588	.....	6534.6
	17	3.30 p. m.	.....	601.7	26	73	23.662		
	17	5 p. m.	.....	601	22.5	69	23.630		
	18	5.30 a. m.	.....	598.3	2.5	35	23.542		
	18	6.25 a. m.	.....	598.2	2.5	36	23.531		
	18	6.45 a. m.	.....	598.9	5	39	23.544	23.578	
First summit	18	9 a. m.	117.95	585.5	19.5	65	22.940	.....	7270
High summit	18	2 p. m.	126.70	556	17	60	21.846	.....	8618.9
Camp 14, side of mountain	18	3 p. m.	.....	560.2	17	60	22.027	.....	8335.4
	18	3.30 p.	.....	560.1	16.5	59	22.027		
	18	4 p. m.	.....	560	13.5	56	22.045		
	18	6.30 p. m.	.....	559.4	9	47	22.045		
	19	Sunrise	.....	556.9	2	36	21.915		
	19	7 a. m.	.....	556.6	2	37	21.895	21.987	
Camp 15, Weber river	19	5 p. m.	145.95	616.1	13.5	59	24.259	.....	5672.1
	19	5.30 p. m.	.....	616.3	13.5	57	24.257		
	19	6 p. m.	.....	616.3	13	54	24.286	24.267	
	20	Sunrise	.....	614.8	5	42	24.183		
	20	6.30 a. m.	.....	614.9	7	43	24.168		
	20	7.17 a. m.	.....	614.3	6.5	43	24.139		
Weber river at Kamas prairie	20	11 30 a. m.	157.95	602.1	9	57	23.630	.....	6319.6
Divide on Kamas prairie	20	2 p. m.	.....	598	8.5	46	23.525	.....	6505
Bank of Timpanogos river	20	3 p. m.	166.65	603.9	12	52	23.759	.....	6242.8
	20	3 10 p. m.	.....	603.8	11.5	51	23.761	23.760	
Camp 16, near river	20	5 p. m.	.....	591	7	45	23.290	.....	6775.6
	20	6 p. m.	.....	591	5	42	23.279		
	21	6 a. m.	.....	589.9	6.5	42	23.193		
	21	6.35 a. m.	.....	590.1	6.5	43	23.195		
	21	7 15 a. m.	.....	590.3	3.5	39	23.207	23.233	
Timpanogos river	21	8 a. m.	172.35	607.4	9	53	23.841	.....	6055.7
Head of long plain	21	11 a. m.	177.75	615.4	11.5	52	24.130	.....	5739
Foot of hill before passing over a spur	21	12 m.	182.75	620.4	14.5	64	24.341	.....	5516.9
River bank	21	12.40 p. m.	183.45	620.8	16.5	65	24.362	.....	5494
Head of cañon	21	2 p. m.	188.15	621.7	15	60	24.433	.....	5481.5
Still in cañon	21	3 p. m.	191.15	623.2	14	59	24.511	.....	5390.3
Camp 17, Timpanogos river	21	6.30 p. m.	199.15	627.3	13	55	24.671	.....	5056.9
	21	7 p. m.	.....	627	11	53	24.662		
	22	5.30 a. m.	.....	628	3	37	24.711		
	22	6 a. m.	.....	628	5	42	24.698		
	22	6 30 a. m.	.....	628	7	46	24.683	24.685	
Camp 107, 1853, American fork	Nov. 5	3 p. m.	213.35	647.5	19	68	25.448	.....	4596.2
	5	6 p. m.	.....	646	12	52	25.416		
	5	9 p. m.	.....	646	9	48	25.398		
	6	6 a. m.	.....	645.7	6	42	25.391	25.411	
Great Salt Lake City	April 22	.....	248						

VI.—*Data for profile from Smith's Fork, Green River valley, to that of Great Salt lake, via the Timpanogos river.*

Station.	Date.	Hour.	Intermediate distances.	Distance from Smith's Fork.	Altitudes above the sea.
	1854.				
Smith's Fork, near Fort Bridger	April..11, 12	Camp			7254.4
Black's Fork	April.....11	9 40 a. m		9.00	7880.3
Divide of Black and Muddy	April.....11	8 a. m	12.25	21.25	8373.7
Divide of Bear and Muddy	April.....10	10.30 a. m	6.10	27.35	8133.3
Divide of Bear and White Clay creek	April.....9	11 a. m	12.90	40.25	7490.8
White Clay creek	April.....17	10 a. m	11.50	51.75	7009
White Clay creek, Camp 13	April..17, 18	Camp	8.75	60.50	6534.4
White Clay creek, Camp 4	April...7, 8	Camp	10.00	70.50	5692.1
Weber river, Camp 15	April..19, 20	Camp	5.25	75.75	5671.9
Kamas prairie	April.....20	11.30 a. m	12	87.75	6319.4
Timpanogos river	April.....20	3 p. m	8.70	96.45	6242.6
	April.....21	8. a. m	5.70	102.15	6055.5
Timpanogos river, head of Round prairie	April.....21	11 a m	5.20	107.35	5738.8
Timpanogos river	April.....21	12 m	5	112.35	5516.7
Timpanogos river, foot of Round prairie	April.....21	12.40 p. m	0.70	113.05	5493.8
Timpanogos river, head of cañon	April.....21	2 p. m	4.70	117.75	5484.3
	April.....21	3 p. m	3	120.75	5394.1
Camp near foot of cañon	April.....21	Camp	8	128 75	5076.7
American Fork	Nov. 6, 1853		14.20	142.95	4796
	1854.				
Camp west side of the valley of the Jordan, on the base of the mountain	May 6		39.60	182.55	4657

VII.—*Data for profie from Great Salt Lake valley, via the Weber river, to White Clay creek, the preceding profile being in common with this from the latter point eastward.*

Station.	Date.	Hour.	Intermediate distances.	Distance from Smith's Fork.	Altitudes above the sea.
	1854.				
White Clay creek, Camp 4	April.....7	Camp		70.50	5692.1
Dry creek, Camp 3	April.....6	Camp	16.50	87.00	5419.1
Sheep rock, Weber river	April.....6	12.15 p. m	8.50	95.50	5189.5
Ben Simons' creek, Camp 2	April.....5	Camp	12.20	107.70	4842
Weber river, below the mountain	April.....5	1.45 p. m	7.80	115.50	4424.1

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt Lake City, Utah Territory, to Fort Reading, in the valley of the Sacramento river, California*—1854.

NOTE.—It is to be noted that in the entries in the column headed "barometric means" the upper entry is for barometer No. 496; the lower for barometer No. 551. The altitudes are entered opposite the heads of the means from which they are deduced.

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Left Council House, Great Salt Lake City, at 5 p. m.	May 5	3 p. m.	.....	.....	642.3	16.2	644	16.1	65	25.255	25.322	.....	4351	Slight fall of rain; wind southwest.
Jourdan ferry, Camp No. 1	5	.....	2.45	2.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Camp 2, good grass, brackish water	6	6 p. m.	12.98	15.43	643.2	14.9	643.2	14.7	59	25.294	25.294	.....	4657	Dark clouds; wind southwest.
	7	Sunrise	.....	.....	645.2	3.9	643.2	3.9	39	25.383	25.305	25.338 25.299	.....	Cloudy; wind southwest; snow for two hours.
Left camp 2 at 6.50 a. m.														
Camp 3, west side of Tuilla valley	7	Sundown.	20.59	36.02	645	5	645	5.5	41	25.396	25.393	25.419	4487.5	Squally; wind southwest.
	8	Sunrise.	.....	.....	646.6	3	647.1	3	34	25.443	25.463	25.428	.....	Heavy clouds; wind southwest.
Camp 4, opposite Stansbury's island, Great Salt lake.	8	3 p. m.	13.70	49.72	654.5	15.5	653	15.5	62	25.731	25.676	.....	4238	Light clouds; wind northwest.
	8	Sundown.	.....	.....	654.8	10	652.3	9.7	48	25.757	25.758	25.730	.....	Heavy clouds in the east.
	9	Sunrise.	.....	.....	653.6	6	651.8	6	38	25.703	25.632	25.688	.....	Heavy clouds in south; wind southeast.
Camp 5, west side of Mountain creek, in Lone Rock valley.	9	4 p. m.	21.45	71.17	648.4	17.9	647.6	17.9	68	25.498	25.467	.....	4444.3	Light clouds; wind northwest.
Dry creek, coming from the west	9	Sundown.	.....	.....	648.4	10.9	649.5	10.5	49	25.501	25.544	25.501	.....	*Light clouds in the east*; wind south.
	10	Sunrise.	.....	.....	648.1	1.9	648.6	2	33	25.506	25.522	25.511	.....	Heavy clouds; wind east.
Entrance into Cedar Mountain pass	10	3 p. m.	10.26	81.43	627.9	17	625.3	17.9	59	24.684	24.578	.....	5469.5	Heavy clouds; wind southwest.
	10	4 p. m.	1 54	82.97	626.8	19	624.7	19.5	64	24.648	24.561	.....	5528.4	Light clouds; wind east.
Camp 6, in pass	10	5 p. m.	.....	.....	626	16	624.1	19	61	24.633	24.543	.....	5576.5	*Heavy clouds; wind southwest.*
Camp 6, in pass	10	6 p. m.	3.24	86.21	626.1	16	623.4	16	57	24.617	24.511	24.530	5580.5	Light clouds; wind north.
Summit of Cedar Mountain pass	11	Sunrise.	.....	.....	621.3	4	621.5	4	36	24.443	24.451	24.481	.....	Heavy clouds; wind southwest.
	11	9.30 a. m.	2.15	88.36	607.3	11	610.2	10.5	60	23 822	23.936	23.794	6364	Heavy clouds; wind northeast.
First descent of Mountain pass	11	10.30 a. m.	.....	.....	606.5	16	609.3	15	59	23.766	23.887	23.911	.....	*Light clouds.*
	11	11.30 a. m.	.23	88.59	613.3	18.9	614.1	17.3	69	24.031	24.071	24.032	6186	
Camp 7, west side of Cedar Mountain pass	11	12.30 p. m.	.....	.....	612.4	16.5	611.6	16.3	60	24.033	24.001	24.036	.....	
	11	6.20 p. m.	1.30	89.89	624 5	12	621.7	11.9	52	24.567	24.457	.....	5575	
	11	7.10 p. m.	.....	.....	623.9	8.5	621	8.5	44	24.546	24.436	24.547	.....	Wind northeast; signs of rain.
	12	Sunrise.	.....	.....	623.7	5.6	622.8	5.3	39	24.530	24.498	24.463	.....	*Rain; wind southeast.*
Foot of mountain	12	8 a. m.	2.43	92.32	639.5	9.5	639.9	9	30	25.108	25.128	.....	4775.5	Heavy clouds in east; wind north.
Camp 8, at Granite mountain*	12	6.40 p. m.	17.33	109.65	645.4	15.5	644.6	15	59	25.370	25.338	.....	4666.4	Heavy clouds in south; calm.
Camp 9, eastern base of Goshoot mountain, at fine spring; grass, but no wood.	13	7.20 p. m.	25 32	134.97	646 5	10.5	642.8	10	52	25.425	25.283	.....	4659·5	Clear; strong southwest wind.
(Not in line of profile)	14	6 a. m.	.....	.....	646	6.5	645.1	6	41	25.399	25.367	.....	.....	*Cloudy*; wind northeast.
	14	12 m	.....	.....	645.2	16.9	643.7	17	69	25.310	25.247	.....	.....	Do do.
	14	3 p. m.	.....	.....	646.1	18	643.6	18.5	69.5	25.393	25.294	25.390	.....	Clear; wind southwest.
	14	6.10 p. m.	.....	.....	646.5	12.5	645 4	12	54	25.424	25.381	25.314	.....	Squally; wind southwest.
	15	Sunrise.	.....	.....	647.9	7.5	648.1	7	41	25.476	25.488	.....	.....	*Squally; wind northeast.*
Summit of mountain in pass, (not in profile)	15	2.30 p. m.	13.10	148.07	.....	.....	609.5	14	59	.....	23.961	.....	.....	Cloudy; snow in the night.
Camp 10, Pangwich or Fish creek	15	Sundown.	5.53	153.60	634.3	14.2	632.1	14.5	56	24.930	24.843	.....	6233.2	Cloudy; in the northwest squally.
Exploring the Goshoot mountains for a pass	15	9.45 a. m.	.....	.....	614.2	9.3	.....	.....	49	24.193	.....	.....	5076.5	Clear; wind northwest.
(Not in profile line.)	15	11.20 a. m.	.....	.....	605.3	10.9	.....	.....	57	23.743	.....	.....	5903.5	
	15	1 p. m.	.....	.....	618.4	13.6	.....	.....	58	24.287	.....	.....	6473.1	
Fish creek, near Desert line of profile	15	3.15 p. m.	.....	.....	635.8	16.6	.....	.....	62	24.999	.....	.....	5852.3	
													5073.2	From camp at Granite Mt., 39.8 miles across the Desert, and 16.5 miles to camp on Fish creek.
	16	Sunrise.	.....	.....	635	3	633.9	3	39	24.988	24.944	.....	.....	Clear; wind east.
Summit of mountain spur	16	5 p. m.	14.13	167.73	611.5	13.5	609.3	13.7	59	24.074	23.987	.....	6154.1	Cloudy; wind northeast.

* From this point the profile passes the Goshoot mountains by crossing the Desert to Fish creek, and thence ascending this stream to our camp of the 15th instant—the distances being 39.8 miles to the creek station, and 16.5 miles thence to camp.

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt Lake City to Fort Reading*—Continued.

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 11, in mountain pass	May 16	10 p. m.	7.47	.....	611.1	12	610.5	11.9	39	23.962	23.939	.....	.....	Rain.
Camp 11, in mountain pass	16	10 p. m.	7.47	175.19	611.1	12	610.5	11.9	39	23.962	23.939	23.996	6073.1	Clear and calm.
	17	Sunrise	.....	.....	610.9	5	609.7	5.7	36	24.041	23.980	23.959	.....	Cloudy; wind northwest.
On ascent to divide between 1st and 2d creeks of the pass.	17	8.5 a. m.	1.82	177.01	605	13	605.3	13.5	59	23.738	23.750	.....	6485.4	Clear; wind northwest.
	17	9.5 a. m.	1.12	178.13	602.8	16.3	602.4	16.9	67	23.630	23.614	.....	6684.2	Do do.
Ascending 2d creek	17	10.5 a. m.	1.25	179.38	602.6	16.9	602.7	17	70	23.612	23.612	.....	6717	Do do.
Summit of pass	17	11.5 a. m.	1 93	181.31	595.7	16.9	596.2	17	64	23.335	23.355	.....	6992.2	Cloudy in the south; wind northeast.
Camp 12, good grass, wood, and water	17	12.20 p. m.	1.42	182.73	600.4	13.6	601.4	13.6	57	23.565	23.606	.....	6550.3	Thunder; wind southeast.
	17	Sundown	.....	.....	600.6	11.9	599.8	12.3	54	23.619	23.575	23.628	.....	Do do.
	18	Sunrise	.....	.....	602.4	4	601.4	4	32	23.700	23.661	23.614	.....	Clear; wind southeast.
Foot of mountain	18	9 a. m.	8.38	191.11	614.6	14 9	616.6	15	60	24.102	24.177	.....	6034.4	Clear and calm.
In open valley, Goshoot lake, to the left	18	12 m.	6.86	197.97	618.1	21.6	619.5	21.6	68	24.227	24.282	.....	5952.4	Clear; wind northeast.
Camp 13, (spring) grass and willows	18	3 p. m.	3.22	201.19	617.7	22	618.2	22	69	24.263	24.282	.....	5859.3	Clear; wind northwest.
	18	Sundown	.....	.....	617.8	20	616.9	22.6	60	24.260	24.217	24.267	.....	Do do.
	19	Sunrise	.....	.....	617	2.9	616.2	3	32	24.279	24.247	24.248	.....	Do do.
Base of hill	19	8 a. m.	3.30	204.49	616	21.5	615.2	21.9	71	24.140	24.108	.....	6121.4	Clear; wind northeast.
Top of deep ravine	19	10.30 a. m.	5.07	209.56	605.2	20.6	604.5	20.8	70	23.695	23.668	.....	6635.2	Do do.
Passing over a mountain spur, extending into valley.	19	12 m.	1.65	211.21	604.8	25	603.6	24.8	73	23.692	23.645	.....	6665.1	Do do.
On a spur of mountain	19	1.15 p. m.	2.57	213.78	602 8	26.3	603.1	26.6	73	23.630	23.642	.....	6710.1	Do do.
	19	1.45 p. m.	.54	214.32	601.9	25	602.5	25.9	73	23.612	23.632	.....	6726.1	Do do.
Camp 14, good water and grass	19	3.10 p. m.	2.92	217.24	612.6	29.4	611.2	29	73	24.036	23 985	.....	6165.1	Do do.
	19	Sundown	.....	.....	611.8	24.9	610.3	22.9	66	23.976	23.925	24.044	.....	Do do.
	20	Sunrise	.....	.....	613.4	7	612.7	7	39	24.121	24 094	24.001	.....	Clear; wind southeast.
Camp 15, Franklin river, in large meadows of grass, on plain east of Humboldt mountains.	20	Sundown	21.52	238.76	614.5	21.3	613.3	21.7	71	24.126	24.075	24.159	6004.2	Clear; wind west.
Camp 16, Franklin river, extensive grass fields.	21	Sunrise	.....	.....	615	5	613.6	5	37	24.192	24.137	24.106	.....	Clear; wind east.
	21	3.30 p. m.	14.84	253.60	614.5	24	612.9	24.5	75	24.136	24.073	.....	6061.4	Clear; wind southwest.
	21	7 p. m.	.....	.....	615.5	24.5	613.8	24.4	69	24.158	24.091	24.142	.....	Do do.
	22	Sunrise	.....	.....	613.6	5.9	613.8	6	39	24.133	24.141	24.101	.....	Clear; wind northeast.
Crossing a mountain stream	22	10.30 a. m.	7.65	261.25	608.8	26.3	609.1	26.6	76	23.814	23.835	.....	6506.3	Clear; wind northwest.
Foot of pass, in Humboldt mountains	22	1.30 p m.	.....	263.30	607.9	21.9	608 7	22	73	23.856	23.883	.....	6433.1	Not in line of profile.
Summit of pass	22	2 p. m.	2.89	264.14	604.5	21.9	605.3	22	73	23.732	23.760	.....	6579.1	Cloudy; wind southwest.
On stream, western slope of pass	22	3 p. m.	.80	264.94	606.3	24.9	607.5	25	78	23.806	23.849	.....	6516.4	Do do.
Camp 17, good grass and water. Not in line of profile.	22	7.20 p. m.	.....	265.56	607.6	16	608 4	16.8	59	23.874	23.905	23.862	6274.2	Squally; heavy clouds.
	23	Sunrise	.....	.....	606.8	8.9	607.5	9	42	23.854	23.881	23.893	.....	Clear; wind northwest.
Camp 18. Not in line of profile	23	3.20 p. m.	.....	264.85	.....	.....	605.8	24	77	.....	23.791	23.761	6520.2	Heavy clouds; thunder.
	23	7 p. m.	.....	.....	604.4	14.5	605.5	14.9	63	23.761	23.800	23.795	.....	Rain and thunder.
On creek, valley of Humboldt river*	23	12 m.	.....	.....	626.4	25.7	.....	.....	82	24.534	.....	.....	.....	Cloudy.
	23	1 p. m.	8.36	273.21	625.3	26.4	.....	.....	86	24.511	.....	.....	5770.4	Do.
	23	1.30 p. m.	.....	.....	623 4	23.2	.....	.....	75	24.458	.....	.....	.....	Mean of last 3 observations.
	23	2 p. m.	.....	.....	623	24	.....	.....	78	24.449	.....	24.472	.....	Do do.
Camp 18, east of Camp 17	24	Sunrise	.....	.....	602.6	9	604.3	9.3	44	23.688	23.755	.....	.....	Cloudy; wind northwest.
On mountain spur, eastern base of Humboldt mountain.	24	10.20 a. m.	6.25	271	597.1	19	598.2	19.5	67	23.383	23.422	.....	6946.1	Clear and calm.
Crossing mountain stream	24	1 p. m.	4.50	275.50	605.9	22.9	606.2	23	73	23.763	23.854	.....	6505.1	Cloudy; wind northwest.
Camp 19, near forty hot springs	24	Sundown	8.45	284.06	606	11.5	606.9	11.9	52	23.830	23.826	23.848	6288.2	Heavy rain from 4 to 7 p. m.
	25	Sunrise	.....	.....	607.5	13	608.6	13.5	56.3	23.866	23.909	23.885	.....	Cloudy; heavy rain all day.
Camp 20	26	.....	7.97	292.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Camp 21, wood, water, and grass	27	7.10 p. m.	13.91	305.94	608.3	16.3	607.7	16	60	23.904	23.881	23.910	6245.2	Cloudy; wind southwest.
	28	Sunrise	.....	.....	608.1	6.3	607.9	6	41	23.917	23.909	23.895	.....	Cloudy; wind northwest.
At base of pass of Humboldt mountains	28	2 p. m.	22.07	328.01	604 9	11.5	603.4	11.5	52	23.785	23.726	.....	6425.2	Strong wind from northwest.
On summit of pass in Humboldt mountains	28	4 p. m.	3.11	331.12	592.3	9	594.6	9	49	23.329	23.419	.....	6818.4	Strong wind from northwest.
Camp 22, south branch of Humboldt river	29	Sunrise	9.93	341.05	616.1	0	615.4	0	26	24.255	24.228	.....	5706.4	Clear; snow in mountains.
Base of hill	29	10.20 a. m.	1.55	342.60	617.6	6.2	615.8	6.4	39	24.240	24.169	.....	5828.5	Clear; wind northwest.

Foot of cañon		29	12 m	3.83	346.43	616.6	.7	618.6	6.9	47	24.223	24.302	.....	5813.1	Do do.
Summit of cañon		29	1 p. m.	1.45	347.88	614.1	11	614.8	10.9	49	24.129	24.157	.....	5960.4	Do do.
Camp 23, South fork of the Humboldt		29	Sundown.	9.19	357.07	609.3	4.5	611.1	4.9	39	23.986	24.053	23.935	6066.2	Do do.
		30	Sunrise	.....	.....	607	2.9	608.9	3	31	23.885	23.960	24.006	.....	Do do.
On summit of spur		30	9 a. m.	1.95	359.02	599.8	11	602.1	10.9	51	23.531	23.622	.....	6627	Do do.
Descent from ditto		30	10 a. m.	2.40	361.42	606.3	9	607	9.5	52	23.785	23.813	.....	6374.3	Do do.
Descent base of hill on left		30	11 a. m.	2.37	363.79	608.2	10	610	10.5	54	23.851	23.922	.....	6288	Cloudy; hail; wind northwest.
Top of mountain		30	1 p. m.	1.45	365.24	604	13	606.9	14	54	23.724	23.834	.....	6411	Cloudy; wind northwest.
At stream at base of mountain		30	3 p. m.	1.26	366.50	620.9	14	622.4	14.4	60	24.420	24.479	.....	5681	Do do.
Camp 24, on bank of stream		30	Sundown.	1.11	367.61	625	17.5	626.8	16.9	49	24.553	24.624	24.567	5368.1	Clear; wind northwest.
		31	Sunrise	.....	.....	624.4	0	626.2	−0.5	23	24.582	24.653	24.638	.....	Do do.
West side of stream		31	9 a. m.	5.79	373.40	625.5	16.3	624.7	16.5	74	24.523	24.492	.....	5693.3	Do do.
Ascending		31	11 a. m.	5	378.40	615.5	20	616.3	20	72	24.099	24.130	.....	6139.4	Cloudy; wind southeast.
On a summit		31	2.45 p. m.	4.67	383.07	612 2	18.9	611.1	18.6	66	24.054	24.011	.....	6197	Cloudy; wind southwest.
On stream		31	.....	4.28	387.35	611.6	16	610.8	16.6	60	24.064	24.033	.....	6140.2	Do do.
Camp 25, *creek, sage and grass*		31	Sundown.	2.20	389.55	609.5	13.9	610.3	14	52	23.954	24.025	23.945	6150.2	Cloudy; wind northwest.
	June	1	Sunrise	.....	.....	608.8	7.9	609.9	8	45	23.936	23.980	24.002	.....	Clear; wind northwest.
Confluence of streams, base of pass		1	8 a. m.	2.15	391.70	603.6	13.5	605	13.5	59	23.683	23.738	.....	6526.1	Do do.
Ascent of mountain		1	10.30 a. m.	2.50	394.20	583.9	12.5	586.2	12.9	51	22.888	22.979	.....	7387.3	Do do.
Summit of Quartz mountain		1	11.30 a. m.	.64	394.84	580.1	14.9	581.9	15.6	56	22.744	22.810	.....	7615.1	Cloudy; wind northwest.
First descent on stream		1	12 m	.82	395.66	597.8	13.7	599.3	14	56	23.160	23.515	.....	6766.3	Do do.
Camp 26, in Agate Pass		1	7 p. m.	.72	396.38	606.2	9	608	9.4	46	23.851	23.922	.....	6227	Do do.
		2	Sunrise	.....	.....	606.8	5	608.6	5.5	37	23.870	23.940	23.851	.....	Hail and snow.
		2	12 30 p. m.	.....	.....	606.7	10.4	606.7	11	45	23.832	23.828	23.896	.....	Clear.
Camp 27, foot of Agate Pass		2	Sundown.	2.65	399.03	635.1	9	635.9	9	48	24.982	25.013	24.977	5006.5	Rain; wind southwest.
		3	Sunrise	.....	.....	635.2	8.5	635.4	8	46	24.972	24.984	24.998	.....	Cloudy; wind south.
		3	8 10 a. m.	2.56	401.59	642.5	17	642.6	17	59	25.193	25.197	.....	4840.5	Clear; wind southeast.
Base of hill		3	11 30 a. m.	7.34	408.93	640.9	18	640.7	18.5	57	25.118	25.110	.....	4919.5	Rain; wind northwest.
Divide of streams		3	2 p. m.	3.30	412.23	631.8	18.6	631.3	18.9	68	24.815	24.795	.....	5223.3	Clear; wind southwest.
Base of hill, in valley		3	2 30 p. m.	.58	412.81	632.3	19	634.2	19.5	68	24.842	24.913	.....	5241.5	Do do.
Pass between buttes		3	3.40 p. m.	3.52	416.33	626.3	15.8	627.5	15	60	24.635	24.686	.....	5442.2	Cloudy; wind southwest.
On summit		3	4.20 p. m.	.73	417.06	625.7	12 9	627.3	13	54	24.630	24.693	.....	5441.4	Rain; wind southwest.
Camp 28, west side of creek		3	Sundown.	.56	417.62	627.7	13.2	628.6	13.9	51	24.675	24.706	24.670	5296.3	Clear; wind northeast.
		4	Sunrise	.....	.....	627.1	5.6	628.9	5	32	24.665	24.739	24.722	.....	Clear; wind northwest.
In ravine, on stream		4	10 a. m.	3.08	420.70	621.7	18.9	622.4	19	69	24.352	24.380	.....	5829.1	Clear; wind northeast.
In ravine, on stream, base of hill		4	11.20 a. m.	2.39	423.09	609.4	21.9	608.2	22	78	23.865	23.814	.....	6502.2	Clear; wind northwest.
On ascent of mountain		4	12 m	.77	423.86	600.9	21.9	602.9	22.3	70	23.550	23.625	.....	6747.2	Do do.
Top of pass		4	2 p. m.	2.19	426.05	587.3	18.9	589.4	19	69	23.067	23.150	.....	7315.2	Do do.
On stream, running from pass		4	2.40 p. m.	.50	426.55	603.7	22	605	22.5	72	23.710	23.758	.....	6470	Do do.
Camp 29, end of stream		4	Sundown.	2.44	428.99	622.3	18	622	18.3	55	24.453	24.431	24.433	5648.5	Do do.
		5	Sunrise	.....	.....	621.2	11.5	621.7	11	48	24.413	24.433	24.432	.....	Clear; wind northeast.
Base of small hill		5	8.50 a. m.	2.60	431.59	632.9	19.2	633.5	19.5	67	24.805	24.825	.....	5306.3	Clear and calm.
In valley		5	10 a. m.	1.84	433.43	639 4	21.8	641.3	22	69	25.037	25.108	.....	5029.4	Clear; wind west.
In valley, base of hill on the left		5	12 m	8.27	441.70	642.8	28.5	644.4	29	82	25.168	25.227	.....	4955.6	Clear; wind southwest.
On rise in valley		5	1 p. m.	3.90	445.60	642.4	28.8	643.8	29	86	25.172	25.224	.....	4974.5	Do do.
Camp 30, fine mountain stream, good grass		5	10 p. m.	13.49	459.09	633.9	20.3	624.9	20.9	62	24.485	24.520	24.498	5601.1	Do do.
		6	5.30 a. m.	.....	.....	624.1	13.8	624.9	14	56	24.511	24.543	24.531	.....	Do do.
Base of hill		6	8 a. m.	.72	459.81	629.6	18.9	628.9	18	66	24.683	24.659	.....	5483.4	Clear; wind northeast.
Top of hill		6	9 a. m.	2	461.81	622	20.7	621.9	20.4	70	24.366	24.366	.....	5835.1	Do do.
In pass		6	11 a. m.	3.54	465.35	622.7	24.6	621.2	24.4	71	24.363	24.308	.....	5877.2	Do do.
On ascent		6	1.30 p. m.	4.43	469.78	631.5	26	630.1	26	75	24.765	24.710	.....	5449.3	Do do.
Camp 31, on west side of stream		6	Sundown.	3.43	473.21	631.2	12.2	630.3	12	54	24.817	24.781	24.806	5249	Rain and thunder; wind northeast.
		7	Sunrise	.....	.....	630.6	7.7	629.1	7.7	46	24.795	24.735	24.758	.....	Cloudy; wind west
In pass, at base of hill		7	8 a. m.	1.25	474.46	628.3	9.9	628	10.4	50	24.727	24.715	.....	5316.6	Do do.
Descending in pass		7	9.15 a. m.	2.76	477.22	629	13.9	630	14	58	24.667	24.706	.....	5400.6	Do do.
Mouth of ravine, in valley		7	10 30 a. m.	3.74	480.96	642.9	17	643.1	17.4	62	25.188	25.196	.....	4859.6	Cloudy; wind northwest.
Entering pass		7	1.30 p. m.	7.19	488.15	641.8	18.9	640.8	19	66	25.198	25.155	.....	4898.1	Do do
In ravine or pass		7	3.50 p. m.	4.64	492.79	632.1	19.3	631	19	67	24.853	24.810	.....	5288.3	Clear; wind northwest.
Camp 32, water and grass		7	Sundown.	.99	493.78	628	10.5	629	10	59	24.698	24.738	24.734	5259.1	Do do.
		8	Sunrise	.....	.....	629.7	5	629.6	5	36	24.771	24.767	24.752	.....	Clear; wind southwest.
Summit of pass		8	7.30 a. m.	2.25	496.03	614.2	17.3	612.8	17	61	24.090	24.035	.....	6129.2	Clear; wind northwest.
Crossing stream		8	9.30 a. m.	3.73	499.76	651.5	19.5	650.3	19.8	70	25.522	25.475	.....	4561.3	Do do.
In valley		8	3.30 p. m.	16.15	515.91	651.4	21.8	650.2	22	72	25.593	25.545	.....	4493	Do do.
On a small spur of mountain		8	4.30 p. m.	2.73	518.64	646.8	20.5	646.4	20.9	75	25.430	25.411	.....	4686.3	Clear; wind west.
Base of mountain		8	5.30 p. m.	2	520.64	652.2	21 3	.....	.....	71	25.627	.....	.....	4424.3	Do do.
Camp 33, east bank of Humboldt river.†		8	Sundown.	3.40	524.04	656.7	20.3	656.3	20.3	69	25.781	25.765	25.831	4140.9	Cloudy; wind west.
		9	Sunrise	.....	.....	658.9	13.3	659.4	11	47	25.881	25.913	25.899	.....	Cloudy, wind east.
Camp 34, Humboldt river crossing		9	Sundown.	6.80	530.84	658.7	19.8	.....	.....	68.3	25.860	.....	25.859	4147	Clear and calm.
		10	Sunrise	.....	.....	658.4	14.6	657.6	14	54	25.858	25.826	25.826	.....	Do do.

* From this point (in the open valley of Humboldt river) the proposed line for a railroad descends Humboldt river to the vicinity of our camp of June 8. The line explored to the south of this is given in profile by itself, from data in this table from May 21 to June 8.

† At this point we return to the proposed line for a railroad, descending the valley of Humboldt river.

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt Lake City to Fort Reading*—Continued.

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 35, on California road, at Lassen's meadows.	June 10	Sundown..	3.51	534.35	658.8	21.5	657.7	21.9	70	25.856	25.813	25.859	4152.2	Cloudy; wind northeast.
Foot-hills, above H. river	11	Sunrise....	.....	.....	658.4	13.5	657.5	14	53	25.862	25.826	25.819	.....	Cloudy; wind northwest.
In bed of dry creek	11	10 a. m....	9.64	543.99	658.3	24	657.7	25.9	75	25.765	25.734	.....	4309	Cloudy; wind northwest.
	11	2.30 p. m..	7.86	551.85	653	28.9	653.4	29	84	25.614	25 626	.....	4492	Cloudy; wind southwest.
	11	5.30 p. m..	6.93	558.78	641.2	22.8	640.4	22.8	74	25.194	25.158	.....	4938.7	Do do.
Camp 36, not on line of profile	12	Sunrise....	5.13	563.91	615.4	12.6	616.2	12.9	55	24.177	24.208	.....	.....	Do do.
Summit of pass, profile distance 5.50 miles....	12	9 a. m.....	1.95	565.86	629.4	18.9	629.3	18.7	66	24.665	24.661	.....	5473.2	Do do.
Descending from pass	12	1.20 p. m..	10.55	576.41	649	19	649.7	19	65	25.473	25.496	.....	4553.1	Do do.
Descending from pass, not on line of profile....	12	2 p. m.....	.....	.....	648.4	18.9	648	18.9	64	25.464	25.448	.....	4579.2	Do do.
Junction of dry creeks, on descent	12	3.30 p. m..	4.68	581.09	652.4	19.3	651.6	20	65	25.641	25.613	.....	4410.5	Strong northwest wind.
Bed of dry creek	12	4.15 p. m..	1.85	582.94	654.7	18.7	654.5	19	64	25.739	25.731	.....	4275	Do do.
In valley	12	5.13 p. m..	2.55	585.49	651.3	17	653.9	17.8	60	25.734	25.711	.....	4278.2	Cloudy; northwest wind.
Camp 37. This height not used in profile.....	13	5.30 a. m..	7.17	592.66	647.2	10	646.7	10.6	49	25.436	25.413	.....	4544	Rain; wind northwest.
Dry creek, in valley. Distance from second preceding station, line of profile, 8.17 miles.	13	9 a. m.....	3.17	595.83	650.8	12	650.5	12.2	53	25.531	25.519	.....	4451.5	Do do.
On stream, in cañon	13	10 a. m....	1.95	597.78	648.5	16	649.3	16	59	25.415	25.446	.....	4583.3	Do do.
Summit	13	10.50 a. m.	1.37	599.15	642.3	16	642.3	16	57	25.171	25.167	.....	4866.2	Cloudy; wind northwest
Descending into valley	13	12.30 p. m.	2.55	601.70	644.6	16	644.2	16	64	25.296	25.281	.....	4763.4	Do do.
Passing small hills in valley	13	4 p. m.....	7.04	608.74	635.5	17	635.5	17.6	62	24.998	24.994	.....	5076.2	Do do.
Passing small hills, on direct line to Mud lake, by an open passage north.	13	5 p. m.....	2.54	611.28	635.7	14.5	635.8	14.5	59	25.019	25.023	.....	5033	Rain; wind northwest.
			11.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	4134	
* Camp 38, grass, but no water	14	Sunrise....	5.50	616.78	632.6	11.6	632.9	11.8	50	24.468	24.869	.....	5376.2	Do do.
* Summit	14	8.40 a. m..	2.20	618.98	627.9	17.9	627.5	19	60	24.617	24.597	.....	5501.1	Clear; wind northwest.
* In pass	14	9.30 a. m..	1.65	620.63	637.6	20.3	636.4	21	63	24.975	24.534	.....	5353	Do do.
Valley of Mud lake, point of mountain. Distance, by line of profile, 15.39 miles.	14	5 p. m.....	11.54	632.17	659	21	658.8	21	69	25.872	25.860	.....	4134	Do do.
Camp 39, east base of Sierra Nevada	15	Sunrise....	9.88	642.05	659.2	15.3	658.9	15	54	25.886	25.873	25.874	4118.1	Clear; wind west.
	15	Sundown..	.....	.....	658.9	21.7	659.3	21.9	71	25.860	25.876	25.874	.....	Do do.
	16	Sunrise....	.....	.....	660.2	15	660.3	15	58	25.929	25.933	.....	.....	Cloudy; wind west.
At point of mountain	16	8 a. m.....	3	645.05	661.4	20	661.4	21	65	25.923	25.919	.....	4079	Clear and calm.
Foot of Madelin Pass, Smoky creek	21	1 p. m.....	16	661.05	657	29.5	.....	.....	86	25.740	.....	.....	4370	Light clouds; high wind.
	21	12 m	.....	.....	656.9	27.5	.....	.....	82	25.720	.....	.....	.....	Do do.
Smoky creek, head of small cañon	21	11 a. m....	3	664.05	654.3	31	.....	.....	74	25.575	.....	.....	4495.2	Do do.
Smoky creek, ascending pass	21	10 a. m....	3	667.05	649	27	.....	.....	70	25.391	.....	.....	4679.5	Do do.
	21	9 a. m.....	2.50	669.55	646	28.6	.....	.....	74	25.275	.....	.....	4827.3	Do do.
	21	8 a. m.....	2.50	672.05	640.6	24.4	.....	.....	70.5	25.092	.....	.....	5014.6	Do do.
Madelin Pass, camp 44; wood, water, and grass. This altitude not in line of profile.	22	Sunrise ...	2	674.05	639.4	2.9	639.7	3	32	25.161	25 173	.....	4914.5	Clear; wind northwest.
	21	Sundown...	.....	.....	639	16	638.2	16.9	56.5	25.108	25.072	.....	.....	Wind all day.
	21	Sunrise....	.....	.....	637.9	9	637.9	9	41	25.078	25.078	.....	.....	Cloudy in southwest.
	20	Sundown...	.....	.....	640	22.5	640.4	22.5	72	25.120	25.135	.....	.....	Clear; wind southwest.
	20	3 p. m.....	.....	.....	641	28	641.4	28	78	25.152	25.168	25.125	.....	Strong south wind.
	20	12 m	.....	.....	642	26	641.5	26	72	25 145	25.125	25.227	....	Strong northwest wind.

IX.—*Meteorological Observations and Table of Altitudes from Mud lake, via Mud creek, to the summit of the Sierra Nevada and Madelin Pass.*†

Mouth of ravine	June 16	12 m.....	8.85	653.90	652.8	25	652 2	25	73	25.570	25.550	.....	4507.4	Clear; wind west.
Summit of hill	16	1 p. m.....	1.47	655.37	643.7	23.3	643.4	23.3	72	25.244	25.232	.....	4858.6	Clear; wind northwest.
Camp 40, on Mud creek	16	Sundown..	1.88	657.25	654.9	20.8	655	21	69	25.706	25.714	25.711	4275.4	Do do.
	17	Sunrise. ..	.....	.....	654.2	9	653.5	9	45	25,716	25.688	25.701	.....	Cloudy; wind northwest.
In cañon	17	8.20 a. m..	.49	657.74	655.4	18.8	653.1	18.6	67	25.692	25.601	.....	4385.5	Cloudy; calm.

In cañon. (Branches at this point)	17	9.50 a. m..	.46	658.20	653.4	21.8	651.4	22	73	25.582	25.508	.....	4523.5	Cloudy; wind south.
In cañon	17	10.30 a. m.	1.30	659.50	652.2	21.5	650.7	21.9	72	25.534	25.471	.....	4566.7	Cloudy; wind southwest.
Camp 41, Mud creek, water, grass, and wood	17	11.25 a. m.	1.53	661.03	651.7	18.9	650.1	19.4	63	25.535	25.476	.....	.....	Do do.
	17	Sundown	.....	.....	649.3	11.8	649.8	12	51	25.525	25.545	25.558	4406.5	Rain all night; wind south.
Top of 1st terrace	18	Sunrise	.....	.....	651	11.5	650.3	11.5	49	25.582	25.555	25.550	.....	Cloudy; wind south.
Junction of streams in cañon	18	10 a. m.	2.05	663.08	638.7	13	639.5	13.3	55	25.045	25.076	.....	4959.1	Cloudy; wind northeast.
In cañon	18	12.30 p. m.	1.96	665.04	633.8	19	633.6	19.5	65	24.863	24 855	.....	5245.6	Do do.
End of cañon	18	1.40 p. m.	2.17	667.21	627.7	20	627.3	20.7	64	24.643	24 624	.....	5495.6	Do do.
	18	2.50 p. m.	1.82	669.03	619.6	20.9	618.9	19.5	64	24.338	24.319	.....	5843.2	Clear; wind southwest.
	18	3.8 p. m.	.23	669.26	620.5	17.3	619	17.6	62	24.393	24.330	.....	5792	Do do.
Descent	18	4.8 p. m.	1.60	670.86	621.4	18.2	621.9	18.5	67	24.439	24.459	.....	5722.2	Do do.
Camp 42, wood, water, and grass	18	Sundown	.35	671.21	619.1	13	61 .6	13	53	24.336	24.356	24.372	5668.3	Clear; wind west
	19	Sunrise	.....	.....	620.3	5	620.4	5	34	24.401	24.405	24.367	.....	Clear; wind southwest.
	19	6 a. m.	.....	.....	620.4	10	619.4	9.8	42	24.379	24.340	.....	.....	Do do.
Descent	19	10 a. m.	4.30	675.51	.....	.....	622	16.5	56.5	.....	24.376	.....	5742	Do do.
	19	12 m.	2.53	678.04	.....	.....	614.9	16	59	.....	24.121	.....	6049	Do do.
Descending into Madelin Pass	19	1 p. m.	.64	678.68	.....	.....	617.7	19.7	67	.....	24.239	.....	5963.6	Do do.
Madelin Pass, camp 43, wood, water, and grass.	19	4.30 p. m.	1.83	680.51	.....	.....	631.9	24	73.6	.....	24.832	.....	5337	Do do.
	19	Sundown	.....	.....	630.2	21.2	629.3	23.4	69	24.742	24.702	24.760	.....	Do do.
	20	Sunrise	.....	.....	630.3	9	629.4	8.8	41	24.779	24.743	24.759	.....	Cloudy; wind east.

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt lake, Utah Territory, to the valley of the Sacramento river, California*—1854. ‡

Ascent of Sierra Nevada	June 22	8 a. m.	1.56	675.61	637.5	16	637	16.5	55	25.006	24.986	.....	5045.3	
In broad valley	22	9 a. m.	1.55	677.16	636.2	19.3	636.3	19.8	65	24.933	24.933	.....	5163.5	
	22	10 a. m.	1.56	678.72	634.2	20	633.4	20	65	24.840	24.809	.....	5385.6	
	22	11 a. m.	1.55	680.27	631	20.2	630.6	20.5	66	24.709	24.689	.....	5432.1	Light clouds; high wind.
Ascent	22	12 m.	1.56	681.83	628.8	21.5	628.3	21.3	68	24.649	24.629	.....	5511.5	Do do.
Summit of Madelin Pass	22	12.50 p. m.	1.32	683.15	626.1	22	625	22	70	24.555	24.512	.....	5843.5	Do do.
On broad summit of Sierra Nevada	22	1.20 p. m.	.79	683.94	626.7	22	622.9	22	70	24.587	24.437	.....	5667.5	Do do.
	22	2.20 p. m.	2	685.94	625.5	22.6	625.3	22.4	70	24.556	24.552	.....	5620	Do do.
	22	3.20 p. m.	1.98	687.92	627	23.8	626	24	69.5	24.626	24.587	.....	5557	Do do.
	22	4 p. m.	1.94	689.86	620.1	21.9	628.7	22	69	24.726	24.711	.....	5427.5	Do do.
On broad summit; not used in profile	22	5.20 p. m.	2.14	692	627.3	21.3	626.5	21	68	24.658	24.626	.....	5507.5	Do do.
Camp 45, water, wood, and grass ‖ (Distance from preceding profile station, 3.85 miles.)	22	Sundown	1.71	693.71	629.2	13.9	628	14	54	24.730	24.683	24.736	5250.5	Clear; wind northwest.
Broad plain of the Sierra Nevada	23	Sunrise	.....	.....	628.2	—3	628.6	—3	25	24.743	24.739	24.721	.....	Clear; wind southwest.
	23	10 a. m.	6.03	699.74	.....	.....	630.6	21.4	64.5	.....	24.694	.....	5430	Do do.
East from camp of June 23 and 24	23	11.40 a. m.	3.48	703.22	.....	.....	631 3	21.5	71.5	.....	24.737	.....	5420.2	Do do.
	23	10.30 a. m.	2.25	.....	628.3	20.6	.....	.....	64	24.562	.....	.....	5576.2	
	23	12 m.	2.25	.....	631.6	23.8	.....	.....	72	24.747	.....	.....	5411.3	
	23	1 p. m.	1	.....	634.4	23.2	.....	.....	73	24.881	.....	.....	5265.4	Not used in any section.
	23	2 p. m.	1	.....	640 4	26.5	.....	.....	77	25.122	.....	.....	5015.3	
Camp 46, summit of Sierra Nevada	23	Sundown	.86	704.08	630.4	22	629.3	21.2	62	24.746	24.706	24.707	5326.3	Clear; wind southwest.
	24	Sunrise	.....	.....	627.2	6.2	627.3	6.3	32	24.669	24.673	24.689	.....	Cloudy in southeast; wind southwest.
Crossing summit of Sierra Nevada	24	12 m.	13.26	717.34	628.1	23.5	627.8	23.7	72	24.593	24.577	.....	5596.4	Light clouds in southwest.
Camp 47, grass, water, and wood§	24	Sundown	6.27	723.61	628.7	11	627.1	11	48	24.722	24.659	24.750	5230.1	Light clouds; wind southwest.
	25	Sunrise	.....	.....	629.6	2.5	629.3	2.3	28	24.779	24.767	24.713	.....	Cloudy; wind southwest.
Water course	25	12 m.	10.57	734.18	624.8	15.4	624.9	15.6	57	24.515	24.515	.....	5585.5	Clear; wind southwest.
On divide in pass	25	1 p. m.	1.63	735.81	621.1	14.7	620.9	14.9	57	24.389	24.381	.....	5736	Clear; wind northwest.
Stream west of summit of the Sierra Nevada.	25	2.30 p. m.	2.42	738.23	630.9	17.9	630.8	17.6	63	24.790	24.786	.....	5315.6	Do do.
	25	3.40 p. m.	1.73	739.96	632.9	16.9	632.3	17.3	62	24.891	24.867	.....	5207.5	Do do.
On spur. Not in line of profile	25	5 p. m.	.....	.....	623.9	14.3	625	14.9	58	24.558	24.598	.....	5523.2	Do do.
Base of hill in valley	25	6.10 p. m.	3.20	743.16	639.1	15.9	639.1	16	62	25.127	25.127	.....	4932.2	Do do.
Camp 48, fine grass. Not used in profile	25	Sundown	2.14	745.30	646.3	10.2	645.8	10.5	48	25.415	25.395	25.435	4468.4	Do do.
	26	Sunrise	.....	.....	646.4	—2	645.7	—2	19	25.456	25.429	25.412	.....	Clear; wind north.
On the waters of the Sacramento river. Distance from preceding profile station 3.67 miles.	26	7.50 a. m.	1	746.30	648.7	7.9	647.7	7.9	42	25.476	25.441	.....	4472	Clear; wind northwest.
East of stream in Round valley	26	9 a. m.	2.25	748.55	651.2	9.8	650.9	10.7	50	25.555	25.539	.....	4415.7	Do do.
On stream at base of hill, Round valley	26	10 a. m.	2.08	750.63	652.8	11.4	651.7	11 7	53	25.600	25.557	.....	4395	Do do.
Leaving creek	26	11.30 a. m.	1.25	751.88	654.2	13.4	654.6	13.6	53	25.661	25.673	.....	4299.2	Do do.

* Not used in profile.
‡ Line of profile resumed.
‖ From this point to the camp of June 24, 25, the line of profile is direct and the grade uniform, the distance being 21.9 miles.
§ From this point back to the camp of June 22, the line of profile is direct and the grade uniform.
† This table is not used in profile.

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt lake to Sacramento valley*—Continued.

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer. (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Round valley. Not used in profile.....	June 26	3 p. m.....	7.78	759.66	658.8	18	657.4	18	63	25.810	25.838	.....	4174.8	Clear; wind northwest.
Camp 49, west side of stream. Distance from last profile station, 8.8 miles.	26	Sundown..	1.03	760.69	657.9	16.2	656.7	16.3	69	25.844	25.797	25.843	4127.4	Do do.
	27	Sunrise....	.....	.....	656.9	4	656.8	4	38	25.842	25.838	25.817	.....	Clear; wind northeast.
Foot of Round valley, and head of first cañon of the Sacramento or Pitt river.	27	9 a. m.....	4.76	765.45	658.9	16	657.9	16 2	55	25.831	25.791	.....	4153.7	Do do.

X.—*Meteorological Observations and Table of Altitudes in crossing from Madelin to Noble's Pass, summit of the Sierra Nevada.**

Locality.	Date.	Hour.	Intermediate distances.	Distances from foot of Round vale.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
			Miles.	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Camp 50, near the first cañon of the Sacramento.	June 27	Sundown ..	4.58	.....	652.2	19.4	651.7	19	62	25.612	25,588	.....	4467.4	Cloudy; wind west.
	28	Sunrise....	.....	.....	652.7	9	651.6	9	43	25,657	25.613	.....	.....	Cloudy; wind southeast.
	28	Sundown..	.....	.....	.....	.....	651.5	21	74,5	.....	25.572	.....	.....	Clear; wind northwest.
	29	Sunrise....	.....	.....	.....	.....	651	9	47	.....	25.594	.....	.....	Cloudy; wind southeast.
	29	12,20 p. m.	.....	.....	.....	.....	651,2	22.5	72.5	.....	25,526	.....	.....	Light clouds; wind southwest.
	29	4 p. m.....	.....	.....	.....	.....	650.1	24.2	76.3	.....	25,541	25,561	.....	Do do.
	29	Sundown..	.....	.....	648.9	20.4	649	20.7	69	25.474	25 478	25,543	.....	Cloudy in west; wind southeast.
	30	Sunrise....	.....	.....	647.7	9	647	9,3	47	25.460	25.432	.....	.....	Cloudy; wind southeast.
Summit, returning to eastern base of Sierra Nevada.	30	8.15 a. m..	2.25	6,83	632.9	13.9	633,7	13.6	53	24.831	24,862	.....	5195,2	Light clouds; wind southwest.
On terrace.....	30	2 p. m.....	10,17	17	632.2	19,3	631.4	19.6	67	24.830	24,795	.....	5310.2	Light clouds; wind northwest.
Summit	30	3 p. m.....	1.53	18,53	633	21,3	632,5	21.7	66	24,869	24.845	.....	5253.6	Do do.
Camp 51, wood, water, and grass.....	30	Sundown..	1.59	20,12	641	16.4	639	16.6	62	25,183	25,104	25,191	4841.5	Do do.
	July 1	Sunrise....	.....	.....	640,5	4	638.7	4.3	38	25,200	25.129	25,116	....	Clear; wind southwest.
Ascent.....	1	9,40 a. m ..	5,04	25,16	622,3	17,7	622,7	17.3	62	24,383	24.402	.....	5758	Do do.
	1	12 m.....	4.68	29,84	615.1	18,8	615.5	18.8	65	24,117	24.133	.....	6083.2	Clear; wind northwest.
On divide.....	1	2,20 p. m ..	5 68	35.52	610	24	608,7	24.3	68	23,942	23.891	.....	6346	Do do.
Camp 52.....	1	Sundown ..	3.43	38,95	621.1	14.3	619	14.5	56	24,411	24,328	24,441	5492.4	Do do.
	2	Sunrise....	.....	.....	621.6	0	620	—0.2	28	24.472	24.421	24.374	.....	Clear; wind northeast.
On a terrace, plain of Sierra Nevada.....	2	8,40 a m...	4.25	43.20	621.1	17.5	621,1	15.6	57	24,349	24,357	.....	5771,1	Light clouds; wind southwest.
Pine creek.	2	11 a. m....	6.25	49.45	.....	.....	.....	.....	.....	.....	.....	.....	... .	

* This table is not used in profile.

VIII.—*Meteorological Observations and Table of Altitudes and Distances from Great Salt lake, Utah Territory, to the valley of the Sacramento river, California*—1854.*

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Foot of first cañon of Sacramento river*	June 29	11 a. m.	13.74	779.19	675.3	30	.....	.....	80	26.402	.....	.....	3622.4	Clear.
Mouth of Fall river, and head of second cañon.	29	6.30 a. m.	13.50	792.69	677.9	8	.....	.....	46	26.636	.....	26.661	3249.9	Clear; wind northwest.
	29	Sunrise	.....	.....	678	5.5	.....	.....	32	26.669	.....	.....	.....	Do do.
	28	Sundown	.....	.....	679.3	18.2	.....	.....	59	26.679	.....	.....	.....	Do do.
Sacramento river, and mouth of second cañon.	July 21	2.30 p. m.	8.95	801.64	691	29	689.4	29	85	27.094	27.031	.....	2937	Do do.
Mouth of Canoe creek	21	12.30 p. m.	4.70	806.34	693.4	28.5	691.8	28	82.3	27.151	27.089	.....	2867.2	Clear; wind northeast.
† Camp 6, in mountain valley. Not in line of profile.	21	Sunrise	.....	.....	680.6	5.6	681.9	5.6	39	26.756	26.807	26.772	3170.1	Do do.
	20	Sundown	.....	.....	679.7	16.5	677.8	16.5	59	26.710	26.637	26.733	.....	Clear; wind southwest.
Sacramento river	20	9 a. m.	22.50	828.84	709.9	23.8	708.4	24	72	27.794	27.734	.....	2177.2	Clear; wind southeast.
Camp 5, Sacramento river	20	Sunrise	7.50	836.34	717.5	7.5	717.3	7.5	47	28.198	28.190	28.186	1730.3	Do do.
	19	Sundown	.....	.....	717.4	21	717.7	21	71	28.171	28.183	28.184	.....	Do do.
Camp 4, on mountain. Not in line of profile	19	Sunrise	.....	.....	708	10	708.3	10	50.5	27.813	27.825	27.819	.....	Clear; wind northwest.
	18	Sundown	.....	.....	708.1	17	707.6	16.9	65	27.833	27.814	27.823	2086.7	Clear; wind west.
Sacramento river	18	10.15 a. m.	26.50	862.84	737.3	25.5	734.1	25.5	76	28.859	28.733	.....	1156	Clear; wind northeast.
Camp 3, Sacramento river	18	Sunrise	.....	.....	739.5	12	736	12	54	29.052	28.910	.....	.....	Probable error in record of temperature. Not used in computation of altitude of camps.
	17	Sundown	4.70	867.54	737.4	23	733.3	23	74.5	28.955	28.794	.....	1078.1	Clear; wind northeast.
Camp 2, Dribblesby's ferry	17	Sunrise	10.50	878.04	738.5	13	737	13	51	29.127	28.950	.....	954.2	Clear; wind east.
Mouth of McCloud's river	16	6.45 p. m.	5.25	883.29	742.4	23.5	738.2	24	72	29.094	28.925	.....	922	Clear; wind northeast.
Sacramento river	16	11 a. m.	11.75	895.04	745.6	29	741	29	79	29.162	28.981	.....	837.5	Do do.
Camp 1, not in line of profile	16	Sunrise	.....	.....	743.6	21	738.9	21	70	29.170	28.985	28.978	.....	Do do.
	15	Sundown	.....	.....	742.6	31	738.8	31	88	29.121	28.971	29.145	899.9	Clear; wind west.
Fort Reading	12 to 15	.....	22.90	917.94	.....	.....	.....	.....	.....	.....	.....	.....	674.7	Height from mean of four days' observations.

XI.—*Meteorological Observations and Table of Altitudes and Distances for profile from Mud lake to Fort Reading, on the Sacramento river, California, via Noble's Pass.*

Camp 39, east base of Sierra Nevada	June 15 and 16	.....	.....	642.05	.....	.....	.....	.....	.....	.....	.....	.....	4118.1	
Point of mountain, shore of Mud lake	16	8 a. m.	3	645.05	661.4	20	661.4	21	65	25.923	25.919	.....	4079	
Foot of Madean Pass, Smoky creek	21	12 m	12	657.05	656.9	27.5	.....	.....	82	25.720	.....	.....	4370	Above the line of profile.
Warm springs	21	1 p. m.	.....	657.05	657	29.5	.....	.....	86	25.740	.....	.....	.....	
Old shore line	July 5	8.15 p. m.	30	687.05	658.2	23.5	.....	.....	75	25.820	.....	.....	4231.6	Clear.
Camp 55, shore of Honey lake, near boiling springs.	5	9.45 a. m.	7.50	694.55	661	38.4	.....	.....	88	25.853	.....	.....	4285.2	Do.
	4	Sundown	8.50	703.05	660.4	25	659.3	25	76	25.908	25.865	.....	4094.6	Clear; wind southwest.
	5	Sunrise	.....	.....	660.1	12	658.9	12	52	25.980	25.883	.....	.....	Clear; wind northeast.
	5	Sundown	.....	.....	.....	.....	658	24	76	.....	25.936	25.919	.....	Clear; wind southwest.
	6	Sunrise	.....	.....	.....	.....	659.6	14.4	56.5	.....	25.903	25.896	.....	Cloudy; wind northeast.
Willow creek	4	12 m	11.36	714.41	662.4	28.5	661.2	28.5	62	25.932	25.885	.....	4080	Clear; wind northeast.
Camp 54, Roop's rancho	3	4 p. m.	8.64	723.05	656.9	32	655.8	32	88	25.770	25.727	.....	4181	Clear; wind west.
	3	Sundown	.....	.....	656.5	26.5	654.5	26.4	78	25.747	25.672	.....	.....	Clear; wind northeast.
	4	Sunrise	.....	.....	656.7	11	657.8	11.5	50	25.807	25.846	.....	.....	
	7	Sundown	.....	.....	659.7	19	657.9	19	73	25.924	25.853	25.845	.....	Clear; wind southwest.

* Line of profile of Madelin Pass resumed.

† Camps numbered from Fort Reading upward in ascending the river.

XI —*Meteorological Observations and Table of Altitudes and Distances for profile from Mud lake to Fort Reading*—Continued.

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
	July 8	Sunrise....	.....	.....	660.6	3.5	658.8	3.8	32	25.986	25.915	25.802	.....	Clear; wind southwest.
Susan river.....	8	8 a. m.....	4	727.05	658.5	21.8	.....	.....	96	25.805	.....	.....	4221.4	Not in profile.
Top of ravine, (same point as above).....	8	8.15 a. m..	.....	.....	647.5	21.3	.....	.....	64	25.372	.....	.....	4672.2	Clear; wind southwest.
Susan river..	8	10 a. m....	4	731.05	649	21.5	.....	.....	67	25.411	.....	.....	4643.6	Not in profile.
12 o'clock peak.....	8	12 m	.....	.....	623	24.5	.....	.....	71	24.401	.....	.....	5801.5	Clear; wind southwest.
Susan river.....	8	2 p. m.....	4.50	735.55	642.8	25	.....	.....	78	25.220	.....	.....	4909.7	Do do.
Divide between Susan river and Summit creek	9	9.45 a. m..	7.25	742.80	632.1	25.5	.....	.....	76	24.730	.....	.....	5454.1	Do do.
On lake, up Susan river	9	11.20 a. m.	7.25	750.05	627.2	26.2	.....	.....	77	24.538	.....	.....	5679.4	Do do.
Divide between Summit and Pine creeks.....	9	12.45 p. m	2.25	752.30	626.8	28.5	.....	.....	80	24.448	.....	.....	5801.6	
Pine creek, prairie.....	9	12 m	5	757.30	.....	.....	627.6	29	79	.....	24.562	.....	5663.3	Do do.
Plains of the Sierra Nevada.....	9	1.20 p. m..	2.89	760.19	.....	.....	631	27.8	80	.....	24 726	.....	5480.5	Clear; wind west.
	9	2 p. m.....	1.84	762.03	.....	.....	630	28	81	.....	24.700	.....	5516.3	Clear: wind southwest.
Thick pine woods.....	9	2.40 p. m..	1.70	763.73	.....	.....	632.8	28.8	83	.....	24.816	.....	5394.1	Do do.
	9	3.45 p. m..	2.05	765.78	.....	.....	635.2	28.2	82	.....	24.928	.....	5261.1	Do do.
Camp 59, Black Butte creek.....	9	Sundown..	1.55	767.33	634.7	19	634.8	19	60	24.935	24.939	.....	5084.8	Do do.
	10	Sunrise . ..	.....	.....	633.4	4.7	634.3	4.7	34	24.903	24.940	.....	.....	Do do.
	23	Sunrise . ..	.....	.....	632.9	2	634.9	2	32	24.896	24.975	.....	.....	Clear; wind northwest.
	23	Sundown..	.....	.....	634.3	20	633.8	20	71	24.896	24.939	24.909	.....	Clear; wind southwest.
	24	Sunrise . ..	.....	.....	633.3	6	634 4	6	45	24.915	24.895	24.937	.....	Clear; wind southeast.
Bed of dry creek, above Black butte	10	11.40 a. m.	11.69	779.02	614.8	27	613.5	27.3	80	24.069	24.017	.....	6275.4	Clear; wind southwest.
Near a pond.....	10	12.30 p. m..	1.87	780.89	615.3	26.8	613.9	27	77	24.098	24.042	.....	6223.4	Do do.
Small creek and springs.....	10	1.10 p. m...	1.53	782.42	616.1	27	614.7	27	81	24.144	24.089	.....	6194.3	Do do.
Hat creek.....	24	11.40 a. m..	3.75	786.17	616	30.5	.....	.....	80	24.093	.....	.....	6216.2	Do do.
Side of mountain, west of Hat creek.....	24	1 p. m.....	2.75	788.92	618.1	30.5	.....	.....	81.5	24.206	.....	.....	6092.3	Do do.
Spur dividing valley of Wolf creek.....	24	2 p. m.....	.50	789 42	620.1	32.5	.....	.....	88.5	24.309	.....	.....	6015.1	Do do.
Wolf creek.....	24	2.30 p. m...	1.50	790.92	621	32	.....	.....	89	24.339	.....	.....	5983.1	Do do.
Western summit of Sierra Nevada.....	25	7 a. m....	2	792.92	616.8	18.5	615.4	18.5	69.5	24.185	24.130	.....	6074.1	Cloudy; wind southwest.
	11	10 a. m....	.....	.....	623.8	28.5	622.8	28.9	84	24.397	24.289	.....	5948.2	Clear; wind southwest.
Battle creek.....	25	8 a. m.....	5	797.92	626.6	28	624.4	28	90	24.523	24.435	.....	5825.1	Cloudy; wind southwest.
	11	11 a. m....	2.50	800.42	638.2	29.5	636.7	30	85	24.945	24.884	.....	5293.6	Clear; wind southwest.
Western descent of Sierra Nevada.....	11	12 m.....	2.12	802.54	651.1	30	649.7	30	86	25.478	25.423	.....	4691.5	Do do.
Deer flat.....	11	1 p. m.....	2.14	804.68	659.2	31	657.8	31	87	25.811	25.768	.....	4318.1	Do do.
Western slope of Sierra Nevada.....	11	2 p. m.....	1.69	806.37	662.8	31.6	661.7	31.6	88	25.971	25.928	.....	4146.3	Do do.
Hill's rancho, on Battle creek.....	25	3 p. m.....	2	808.37	662.4	29	659.9	29.5	80	25.980	25.880	25.967	4131.6	Cloudy; wind southwest.
	25	Sundown..	.....	.....	661.1	23	658.7	22.8	73.5	25.954	25.861	25.870	.....	Cloudy; wind northwest.
Descending Sierra Nevada.....	11	5 p. m.....	4.14	812.51	666.2	28	664.6	28	82	26.154	26.087	.....	3934.7	Clear; wind southwest.
	11	7.20 p. m...	3.58	816.09	674.9	26	....	....	80	26.567	.....	.....	3445.7	Do do.
Camp 61, McCumber's mill.....	12	Sunrise . ..	1	817.09	675.2	16	672.7	16	59	26.500	26.402	.....	3491.1	Clear; wind northeast.
On stream.....	12	8 a. m.....	2.38	819.47	678.3	26.3	676.1	26.5	78	26.555	26.468	.....	3497·8	Clear; wind southwest.
Descent.....	12	9.30 a. m...	3.05	822.52	696.3	30.3	694.9	30.5	86	27.227	27.172	.....	2796	Clear and calm.
On stream.....	12	10 a. m	2.19	824.71	709.6	32.5	707.9	32.5	91	27.741	27.671	.....	2280.2	Calm.
On descent in valley.....	12	11.30 a. m..	3.78	828.49	727.8	37.5	726.4	37.9	99	28.435	28.380	.....	1576.4	Clear; wind northeast.
	12	12 45 p. m .	2.93	831.42	740.5	40.7	737.9	41	106	28.951	28.848	.....	1087.4	Do do.
On dry creek.....	12	1.45 p. m...	2.54	833.96	745.8	42.7	742.4	42	109	29.167	29.037	.....	887.3	Clear; wind northwest.
	12	3.40 p. m...	4.37	838.33	749.5	41.6	746	42	108	29.351	29.213	.....	706.5	Do do.
Fort Reading, camp 62....	12	Sundown..	2.25	840.58	750.3	36.2	744.3	36.5	100	29.396	29.190	.....	674.7	Do do.
	13	Sunrise . ..	.....	.....	750.2	20	746.5	20	67	29.434	29.288	.....	.....	Clear and calm.
	13	Sundown..	.....	.....	748.5	35	744.8	35.5	95	29.333	29.184	.....	.....	Clear; wind southeast.
	14	Sunrise . ..	.....	.....	749.4	25.5	744.9	25.3	72	29.375	29.198	.....	.....	Clear; wind northeast.
	14	Sundown..	.....	.....	748.7	34.2	744.3	34.5	93	29.345	29.168	29.386	.....	Do do.
	15	Sunrise . ..	.....	.....	750.3	26.2	745.8	26.5	79	29.434	29.228	29.209	.....	Do do.

XII.—*Meteorological Observations and Table of Altitudes on the road leading through Noble's Pass.**

Locality.	Date.	Hour.	Intermediate distances.	Distances from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		*Miles.*	*Miles.*	*Mm.*		*Mm.*			*Inches.*	*Inches.*	*Inches.*	*Feet.*	
Ascent of Noble's Pass	July 8	7.30 a. m.	1.04	.....	.....	.....	653	18	58.5	.....	25.609	.....	4385.1	Clear; wind northeast.
	8	8.45 a. m.	2.72	.....	.....	.....	647.8	19.3	61.5	.....	25.389	.....	4611.3	Do do.
Ascent of Noble's Pass, (small stream)	8	10 a. m.	2.51	.....	.....	.....	641.1	21.5	65.5	.....	25.100	.....	4980	Do do.
	8	11.15 a. m.	2.77	.....	.....	.....	633.4	21	67.5	.....	24.804	.....	5322.5	Do do.
Ascent of Noble's Pass, (spring)	8	12 m.	1.43	.....	.....	.....	632.6	22.7	70	.....	24.786	.....	5356.4	Do do.
	8	1.30 p. m.	2.84	.....	.....	.....	620.3	23.2	69.5	.....	24.330	.....	5874.5	Do do.
	8	2.20 p. m.	1.69	.....	.....	.....	617.6	25.3	72	.....	24.235	.....	6000.1	Do do.
Eagle butte, overlooking lake	3	9.40 a. m.	.....	.....	609.4	19	609.1	19.6	66	24.871	24.859	.....	6392	Clear.
	8	3.40 p. m.	2.28	.....	.....	.....	623.6	24.5	75.3	.....	24.489	.....	5726.1	Clear; wind southwest.
Camps 53 & 58, Summit creek	2	Sundown.	2.35	.....	623.5	16	622.7	16	60	24.499	24.467	.....	5460	Clear; wind west.
	3	Sunrise.	.....	.....	622.5	1	623.7	.7	29	24.503	24.551	.....	.....	Clear and calm.
	8	Sundown.	.....	.....	626.1	17	625.4	17	60	24.609	24.582	24.561	.....	Clear; wind southwest.
	9	Sunrise.	.....	.....	626.1	0	627.1	0	29	24.635	24.674	24.568	.....	Clear; wind northeast.
In direct line for Pine creek	9	8.15 a. m.	3	.....	.....	.....	626.4	20	65	.....	24.544	.....	5603.2	Clear; wind southeast.
	9	9.10 a. m.	3	.....	.....	.....	628.8	22.9	73.5	.....	24.605	.....	5582	Do do.
Open prairie, near Pine creek	9	11 a. m.	1.65	.....	.....	.....	629	28	79	.....	24.589	.....	5632.5	Clear; wind west.

XIII.—*Meteorological Observations and Table of Altitudes in crossing from the mouth of Canoe creek (Poinsett river) to Black Butte creek, and thence west to Hat and Wolf creeks.**

Camp 7, Canoe creek	July 21	Sundown.	.....	.....	687.7	19.5	686.4	19.5	68.5	27.012	26.961	27.022	2897.5	Clear; wind northwest.
	22	Sunrise.	.....	.....	687.5	4.3	687.7	4	41	27.033	27.043	27.002	.....	Clear; wind northeast.
In a ravine	22	12.30 p. m.	.....	.....	666.4	28.5	665	28.5	82	26.095	26.040	.....	3992.1	Do do.
West from camp on Black Butte creek, 4 miles.	24	8.15 a. m.	.....	.....	634.1	27.5	.....	.....	78	24.815	.....	.....	5367.6	
West from last reading 2.50 miles, in valley of Canoe creek, (Poinsett river.)	24	12 m.	.....	.....	657.3	33.5	.....	.....	91	25.706	.....	.....	4400.6	
Hat creek—distance given from spring	10	3.30 p. m.	4.49	.....	640.2	30.8	638.9	31	87	25.111	25.059	.....	5108.4	Clear; wind southwest.
Camp 60, Wolf creek	10	Sundown.	3	.....	633.6	23.5	631.8	23.5	74.5	24.872	24.802	24.871	5245.3	Do do.
	11	Sunrise.	.....	.....	633.1	10.5	632.2	10.5	49	24.870	24.834	24.818	.....	Clear; wind east.
Camp on Wolf creek one mile below the preceding camp.	24	Sundown.	1	.....	634.5	23.5	635	23.8	76.5	24.909	24.920	24.899	5185.5	Thunder; wind southwest.
	25	Sunrise.	.....	.....	633.6	10	634	10	51	24.890	24.906	24.913	.....	Cloudy; wind southwest.

* This table is not used in profile.

CHAPTER X.

Geology.

I.—Geological report of the country explored under the 38th and 41st parallels of north latitude, in 1853–'54, by James Schiel, M. D., Geologist for the expeditions.

II.—Letter from Professor J. W. Bailey, upon infusorial fossils submitted to him by Dr. Schiel.

SIR: In the report which I have the honor herewith to transmit to you, I have endeavored to give a description of the geology of the country through which we travelled after leaving Westport. It may, perhaps, more properly be termed a geology of the road over which we travelled, since the geological exploration had to be confined to those parts of the country which lay in the immediate neighborhood of that road. I have not entered in this report into a too minute, and therefore tiresome description of details; nor have I attempted to found unwarrantable generalizations on restricted and, from their very nature, insufficient observations; but I have tried to represent, in as small a picture as possible, the chief geological features of the explored country. Many things that would have to be mentioned in an independent geological paper—as the shape and elevation of mountains and mountain chains, the configuration of the different parts of the explored country, &c.—have been omitted as a useless repetition of what has been given in your general report of explorations.

In describing the sedimentary rocks of the plains, it must, of course, be left undecided whether, in the succession of the strata as they have been enumerated, there are still some other strata lying between, for sometimes we travel a great distance, and the level changes many hundred feet before we meet again with an accidental outcropping of rock.

Between Westport and the Little Arkansas there is a series of limestone strata composed of rocks which differ in appearance and physical properties, fracture, color, hardness, &c., but which must, nevertheless, be considered as members of one and the same formation. Of the limestone around Westport, which extends into the Shawnee territory, (now Kansas), there is a denudation on a creek near our first camp. It is in some places densely filled with petrifactions, *Terebratula subtilita*, *Spirifer*, (*striatus?*) *Productus splendens*, and two species of *Productus* not to be determined from my specimens, apparently a new species of *Phillipsia*, so as to appear almost as a conglomerate of these shells.

On Indian creek we find a limestone of a yellow red color, not very hard, and interspersed with white crystal leaves belonging to the organic remains of the rock, which have become obliterated by crystallization. It would be impossible to recognise to what kind of organism they belonged, but for the agency of the creek, which, in running over the rock, dissolves the softer part of it, leaving the crystallized parts behind, so that the whole surface of this limestone along the creek is thickly overspread with fossils. They are mostly parts of broken stems of a species of encrinites, fragments of some bryozoa and of some other undistinguishable shells.

The next limestone, found near Willow creek, is gray, hard, of subcrystalline fracture, and includes fossils, *Fenestella*, *Productus semireticulatus*, and *Productus æquicostatus*.

More westward, up to the Little Arkansas, we meet, from distance to distance, with outcroppings of limestone strata, but the rock becomes more compact, sometimes excessively hard, and petrifactions are extremely rare, if they are not wanting entirely. I found in one case only a fragment of a small trilobite in a limestone west of Willow creek. The dip of all these strata, which must be considered as members of the coal formation, is a few degrees northeast.

A white, fine-grained, non-fossiliferous limestone on the Little Arkansas, and a red ferruginous sandstone, out of which Pawnee rock is formed, have a horizontal stratification. The latter is again found on Coon creek, and, according to a specimen brought to me by Captain Gunnison, it extends up to the Republican fork of the Kansas river. It supports a loose conglomerate of quartzose rocks, which is seen to extend some thirty miles along the Arkansas west of Fort Atkinson. It is very probable that these strata belong to the chalk formation, which, going westward, we find distinctly represented by several kinds of limestone strata; the first, about ninety miles from the fort, is a soft, argillaceous, yellowish limestone, with inoceramus. It seems to have a slight dip to the southwest. About thirty miles farther west, we meet with another limestone of the cretaceous period. It is a gray rock, a little harder than the preceding one, and is replete with inoceramus mytiloides. The row of low hills which, in these localities, stand at a short distance from, and extend along the road, consist of this limestone. These hills show lines which mark the banks of an ancient sea; they lie in one and the same horizontal plane, in whatever direction these hills may run.

View of the limestone hills of the valley of the Upper Arkansas: the broken line, *a* ----- *a*, showing the positions of ancient shores.*

* *Note by Lieut. Beckwith.*

The old shore-lines existing in the vicinity of the Great Salt Lake present an interesting study. Some of them are elevated but a few feet (from five to twenty) above the present level of the lake, and are as distinct and as well defined and preserved as its present beaches; and Stansbury speaks, in the Report of his Exploration, pages 158–160, of drift-wood still existing upon those having an elevation of five feet above the lake, which unmistakably indicates the remarkably recent recession of the waters which formed them, whilst their magnitude and smoothly-worn forms as unmistakably indicate the levels which the waters maintained, at their respective formations, for very considerable periods.

In the Tuilla valley, at the south end of the lake, they are so remarkably distinct and peculiar in form and position, that one of them, on which we travelled in crossing that valley on the 7th of May, attracted the observation of the least informed teamsters of our party—to whom it appeared artificial. Its elevation we judged to be twenty feet above the present level of the lake. It is also twelve or fifteen feet above the plain to the south of it, and is several miles long; but it is narrow, only affording a fine roadway, and is crescent-formed, and terminates to the west as though it had once formed a cape, projecting into the lake from the mountains on the east—in miniature, perhaps, not unlike the strip of land dividing the sea of Azoff from the Putrid sea. From this beach the Tuilla valley ascends gradually towards the south, and in a few miles becomes partly blocked up by a cross-range of mountains, with passages at either end, however, leading over quite as remarkable beaches into what is known, to the Mormons, as Rush valley, in which there are still small lakes or ponds, once, doubtless, forming part of the Great Salt Lake.

The recessions of the waters of the *lake* from the beaches at these comparatively slight elevations, took place, beyond all doubt, within a very modern geological period; and the volume of the water of the lake at each subsidence—by whatever cause produced, and whether by gradual or spasmodic action—seems as plainly to have been diminished; for its present volume is not sufficient to form a lake of even two or three feet in depth, over the area indicated by these shores, and, if existing, would be annually dried up during the summer.

These banks—which so clearly seem to have been formed and left dry within a period so recent that it would seem impossible for the waters which formed them to have escaped into the sea, either by great convulsions, opening passages for them, or by the gradual breaking of the distant shore (rim of the Basin) and draining them off, without having left abundant records of the escaping waters, as legible at least as the old shores they formed—are not peculiar to the vicinity of this lake of the Basin, but were observed near the lakes in Franklin valley, and will probably be found near other lakes, and in the numerous small basins which, united, form the Great Basin.

But high above these diminutive banks of recent date, on the mountains to the east, south, and west, and on the islands of the Gaeat Salt Lake, formations are seen, preserving, apparently, a uniform elevation as far as the eye can extend—formations on a magnificent scale, which, hastily examined, seem no less unmistakably than the former to indicate their shore origin. They are elevated from two or three hundred to six or eight hundred feet above the present lake; and if upon a thorough examination they prove to be ancient shores, they will perhaps afford (being easily traced on the numerous mountains of the Basin) the means of determining the character of the sea by which they were formed, whether an internal one, subsequently drained off by the breaking or wearing away of the *rim* of the Basin—of the existence of which at any time, in the form of continuous elevated mountain chains, there seems at present but little ground for believing—or an arm of the main sea, which, with the continent, has been elevated to its present position, and drained by the successive stages indicated by these shores.

At some distance east of Bent's Fort, a hard, compact, gray limestone has an outcropping on the road. It does not seem to include any organic remains; but a yellow red sandstone lying over it contains numerous impressions of shells. It is so soft that in transporting them the specimens of it were crushed to powder in the first hour, and I am left unable to determine to what species they belong. As much as I can recollect of them, they may belong to some species of pecten.

The chain of high and steep bluffs which begins some miles above Bent's Fort, is chiefly made up of two kinds of limestone; the upper one white, pure, hard, and fine-grained nearly to compactness, includes no organic remains, and would, if located in a less remote part of the country, offer a very valuable material to the practical arts, or for building purposes; the lower, a brownish rock, is interspersed with thin layers of crystals of carbonate of lime, and bears some indications of petrifactions, but so undistinguishable that it is hardly possible to make out what they are. The stratification of both is horizontal. To judge partly from what I saw myself, partly from specimens brought to me, a blackish, hard limestone and a soft shale support them; the latter cropping out some twenty miles west of the fort in a kind of bottom land.

Having crossed the Arkansas near the mouth of the Apishpa, (presumed Huerfano,) our road leads over a gravelly and, in general, sterile soil—we are in the great American desert—and over sandstone, through which a number of creeks and rivers have cut their channels. The underlayers of this sandstone are a yellowish, hard, fine-grained rock, the upper part soft, and eaten through by the atmospheric agents.

A few miles east of the cañon through which we entered the mountains proper, a hard, compact, dark-gray limestone, with some slight traces of petrifactions and sulphuret of iron interspersed, and above it a limestone which is apparently identical with the lower brownish limestone near Bent's Fort, crop out with a dip of 8° to 9° to the northeast. They rest on a hard silicious shale, through which igneous rocks have made their eruption near the mountains, forming buttes of sometimes remarkable shape. The most remarkable of them is the Huerfano butte, a little mountain of conical shape, consisting of black granite (quartz and black mica) and the just-mentioned hard silicious shale, the latter lying on the top of the butte.

In concluding the geology of the Plains, I will here mention a kind of geological riddle which I have not been able to solve: About fifteen yards distant from the above-mentioned limestone hills of the cretaceous period, there is a little butte almost as high as the hill to which it stands nearest—about thirty-five feet—and of a shape which will be best seen from the accompanying drawing of it. It stands quite isolated, and consists not of limestone, but of a

Isolated Shale Butte, standing adjacent to the limestone hills in the valley of the Upper Arkansas.

soft foliating shale. Even should that shale be found to support the limestone of these hills—which I could not decide, not having any instruments to dig into the ground—it would still

appear strange that the shale of this butte could lie in the same horizontal plane with the limestone of the hills, and that it should have resisted devastation so long.

An analysis of atmospheric air, which I made in the neighborhood of Fort Atkinson, may also properly find a place here. The mean of three analyses executed with all care after the method of Prof. v. Liebig—absorption of the oxygen by a solution of pyrogallic acid in caustic potash—gave:

Nitrogen	79.09
Oxygen	20.91
	100

This shows, as was to be expected, that the composition of the air on the high prairie does not differ from the well known invariable composition of atmospheric air elsewhere.

On entering the mountains we find a white, fine-grained, very hard sandstone, torn, fractured, and upheaved to nearly a vertical position by plutonic rock. The steep slopes of the mountains are covered with fragments of a white silicious rock, which in some places are of considerable size, forming blocks of twenty and more feet in diameter. The hills on the foot of the higher mountains are covered with drift rocks of all kind—quartz, porphyry, sandstone, &c.; even hypersthene rock is occasionally met with. About fifteen miles west of the cañon through which we entered the mountains, sandstone, and a red shale lying under it, are nearly vertically uplifted by a trachytic porphyry, which seems to have given to those mountains their peculiar shape and elevation. This porphyry consists of a brownish gray, rough base, in which a great number of crystals of feldspar and crystals of black mica are imbedded, forming a rock of great beauty. The crystals of feldspar and mica are mostly perfect, and of the size of one to two tenths of an inch; the latter are hexaëdrix prisms, with basal cleavage. This rock, which forms the ridge from the trail in Sangre de Cristo to the route laid down by Captain Gunnison through that pass, seems to be of a very changeable character. East of the ridge the base of it is of a purer gray, the number of feldspathic crystals is less, and the numerous mica crystals are smaller, sometimes almost of microscopic size; but the basal cleavage is still easily detected. West of the ridge, the mica seems to have passed into tourmalin, the crystals of feldspar being scarce. The rock contains sometimes tolerably large crystallizations of a zeolitic substance, which for its physical properties and crystal form, as well as behavior before the blow-pipe, must be considered as stilbite. The predominating rock in the Sangre de Cristo valley is a feldspathic granite, passing gradually into gneiss on the right bank of the creek, the gneiss supporting a hard shale, sandstone, and a bluish brittle limestone. The latter belong perhaps to that class of non-fossiliferous transition rocks lying under the silurian system,* and the existence of which on this continent has been recognised by several distinguished geologists.

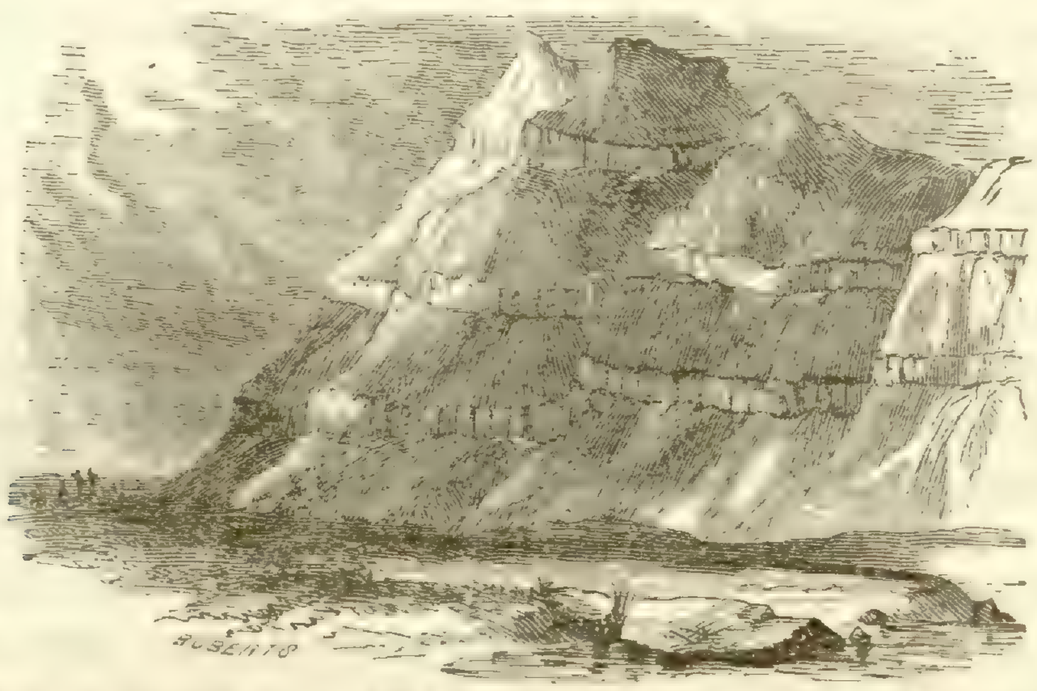
In the neighborhood of Fort Massachusetts there are indications of iron ore, and even faint indications of cobalt ore, but I had neither the time nor the means to follow them up.

In the sandy, and for the most part sterile, San Luis valley, I looked in vain for some section or outcropping of the rock lying under the soil. During many days' travelling, this valley presents nothing but sand; and it was not even possible to ascertain the character of the under-soil. A striking and very curious illustration of the abundance of sand in this valley is found in an isolated row of sand-hills opposite Roubideau's Pass. They are from 500 to 600 feet high, running for several miles in a direction from northwest to southeast. It is very probable that some solid rock is buried under this sand, having been the cause of its accumulation. Along the foot of the White mountains (Sierra Blanca) we found numerous boulders of igneous rocks which do not seem to correspond with the rocks of the neighboring mountains.

* The cambrian system, as distinguished from the silurian system by its age and organic remains, is not recognised any longer by geologists. Comp. Murchison, in Quarterly Journal Geology, soc. VIII, 1852. Murchison's Siluria, 1854.

The chief rock of the Sierra Blanca in and around Roubideau's Pass is an altered, rough, bluish violet, mica slate, through which quartzose, granitic, and porphyritic rocks have erupted, including pieces of each other, so as to form quite a chaos of rocks.

The entrance to the beautiful Sahwatch valley is marked by an isolated butte of hard, gray, granitic porphyry, with glassy feldspar and mica. The valley is formed by picturesque mountains, which are steep, often vertical, or of a true trapp form on the south side, less steep and covered with timber on the north side, where the destruction of the mountains by the melting snows, rains, &c., is less rapid. The rock which constitutes these mountains is a red trapp-porphyry,* with a red feldspathic base, with glassy feldspar and mica. Thin splinters of this base melt with difficulty, on the edges, before a well-directed jet of the blow-pipe.



Limited view of Trapp Rocks, (visible throughout the valley of the Sahwatch creek and its branches,) in ascending the Coochetopa Pass from the east.

[*Note.—The term trapp is used so vaguely, and with so little distinction, that it is often impossible to know what kind of rock is meant by that name. With some authors it seems to designate any kind of igneous, not granitic, rock. That this looseness of language is a general one, will appear from quotations from three distinguished geologists:

"Connected with the aforementioned rocks—diallage rocks, (euphotides;) hypersthene rocks; pyroxene rocks, including basalt, dolerite or greenstone; amphibolic rocks, including diorite or greenstone; trachytic and porphyritic rocks—there is a whole series of rocks which agree with those in so far as all of them contain only simple silicates, whilst the granites and their neighbors, containing an excess of silica, are multi-silicates. But what distinguishes the trappean rocks from all the preceding ones, is *the want of any perceptible structure;* not even the microscope shows any structural elements in the trapp rocks. They are in some manner related to the basalts; they have the same volcanic origin, were in a state of fusion at the time of their formation, and separate like those in regular masses, or even in hexaëdrix prisms. All these rocks, which Haüy called 'aphanites' on account of *their undeterminable structure,* are rough to the touch. It is probable that chemical analysis will offer the means of classification for these rocks; at present this is impossible. In his examination of the trapps of the Ferroe islands, Durocher has pointed out the way chemical analysis has to follow in this respect; he has shown these trapps to consist of two varieties, of which one must be reckoned amongst the hyperites, the other amongst the euphotides; the latter being easily distinguished by its yielding water when heated."—*Elie de Beaumont, in his "Cours de Géologie à l'école des Mines," German version, by C. Vogt.*

"Trapp or greenstone is a dark and heavy blackish-green or brownish rock, consisting of hornblende and feldspar; it *usually has a crystalline texture,* but is sometimes compact. When albite replaces the feldspar, it is called *diorite* and *diabase.* Basalt is a similar rock, &c., &c." *Dana's Mineralogy, (3d edition.)*

"*Trapp* and *trappean rocks.* Volcanic rocks, composed of feldspar, augite, and hornblende.

The various proportions and state of aggregation of these simple minerals, and differences in external forms, give rise to varieties which have received distinct appellations, such as basalt, amygdaloid, dolerite, greenstone, and others. The term is derived from trappa, a Swedish word for stairs, &c., &c."—*Lyell: Principles of Geology.*]

More westward the mica in this rock becomes scarce, though it never disappears entirely from it. Near camp 53, where we left the Sahwatch creek in order to go over the pass, the mountains on the right bank of the little creek, coming down from the north, are composed of a kind of granitic rock, black mica imbedded in a crystalline mass of glassy feldspar. The only sedimentary rock found between Sangre de Cristo valley and Coochetopa creek was a hard, fine-grained sandstone near the divide of the Sierra St. Juan.

On the west side of the Coochetopa Pass, we meet again with two kinds of porphyry; the one resembling the gray porphyry of Sangre de Cristo, the other that of the Sahwatch butte, containing, however, more mica. In the lower regions of the mountains, forming the valley of the Coochetopa creek and the Grand River valley, feldspathic granite, gneiss, a rough silicious shale and a fine mica slate, the latter dissolving only under a powerful lens into a mixture of quartz and mica, and a white sandstone, are the predominating rocks; in the upper regions, sandstone and trapp-porphyry, the latter resembling very much the trapp-porphyry of Sahwatch valley. It consists of a compact, hard, brown-violet feldspathic base, interspersed with crystallized glassy feldspar, and a few mica crystals. Thin splinters of this base melt more easily on the edges before the blow-pipe than the Sahwatch porphyry. This rock lies mostly horizontal, about sixty to seventy feet thick, on the summit of the mountains, over a white sandstone, forming sometimes remarkable platforms. It seems to have an immense extension, for we found it for over a hundred miles along our road. As it must necessarily have been in a state of fusion at the time it spread over the sandstone, we may form an idea as to the scale on which eruptions of igneous rocks have taken place at a time when sedimentary strata of considerable thickness were already in existence.

By contact with granite, this rock has in some places (along Grand river) become blackish and very brittle. It seems to have been displaced when already in a solid state, for it has polished surfaces which could only be produced by its sliding over some other solid rock. I cannot positively assert that this rock is an altered trapp-porphyry, for I could nowhere trace a direct connexion; but in their lithological character, they stand very near each other. The narrow cañon of Grand river, below camp 58, is formed of granite and this rock. Some miles above that cañon, a conglomerate of igneous rocks of all kinds, imbedded in a very hard cement, lies under the sandstone; and when, during and after the gradual upheaval of the mountains, the other rocks were completely washed and worn away, this conglomerate partially resisted the action of time and the weather, so that parts of it are seen hanging over the steep sides of the mountains in the shape of towers, resembling very much those ruins of old castles which, though remnants of barbarous ages, give unequalled charms to so many landscapes in the eastern world. The great hardness of the cement of this conglomerate—I nearly broke my steel hammer in the attempt to break some pieces off—induced me to make some chemical experiments as to its composition. It consists, however, of nothing but impure carbonate of lime, being entirely soluble in diluted chlorhydric acid. The solution evaporated to dryness, and re-dissolved, does not leave a trace of silica behind.

The country between the St. Juan and Wahsatch mountains is a barren, dreary desert. The road leads mostly over sand or its generator, sandstone; which latter constitutes the several smaller mountain ranges between these two great chains. Sandstone, assuming all shades of color, sandy calcareous clay slate, argillaceous limestone of green and red colors, sandy shale, and, uppermost, a soft foliating shale from gray to black, including much fibrous and lamellar gypsum, seem to be the formations composing the "Elk mountains." All these different strata are concordant, and of a slight northeast dip. Some miles distant from where we crossed

the Nah-un-kah-rea, blocks of a dark trachytic porphyry lie over the sandstone and shale, extending some miles along our road. Boulders of this trachytic rock are occasionally met with quite up to the Wahsatch mountains In the valley of the Blue river, a coal measure, supported by sandstone, crops out at several places; but the coal does not seem to be of a good quality. Not far from where the latter river empties into Grand river, a hard conglomerate of pebbles baked together, a hard, bluish limestone, and a dark, silicious shaly rock, with agate, are met with, but do not seem to have a great extension.

That the disintegrations of such rocks cannot yield a good soil is evident, and not much organic life can be expected in such a country. But there does not even seem to have been any organic life in the ancient seas, in which the sedimentary rocks of this country have been deposited. I could not detect any rock including organic remains of any kind whatever. It is true, in the neighborhood of Grand river, near camp 72, there are fragments of a dark gray limestone, with numerous casts of shells—mostly fragments of amonites—strewed over the ground on the top of a sand-hill, together with quite a number of loose shells, "Gryphæa pitcherii," showing the rock to have originated in the cretaceous period; but within a circuit of several miles, it could not be found in situ. The want of petrifactions in the rocks of these desolate regions, renders a determination of their relative ages somewhat hazardous.

It is a remarkable feature in the character of the country between the Rocky mountains and the Sierra Nevada, that whole formations disappear, as it were, before our eyes. The wearing and washing away of mountains takes place here on an immense scale, and is the more easily observed, as no vegetation of any account covers the country, hiding the destruction from the eye. Nature here seems only to demolish, without showing any compensating creative activity. Days before we found the above-mentioned towery conglomerate on Grand river, we saw mostly small pieces of rocks on the road which did not belong to the surrounding mountains, and which afterwards could be identified with the rocks contained in that conglomerate. As these rocks could not have been drifted there from a place about a thousand feet lower, we must conclude that large masses of this conglomerate have been carried away, leaving a number of these rocks behind. All along our road in the Grand and Green river country, on the slopes of high mountains, and in the level country, the soil is overstrewed with pieces of agate, cornelian, calcedony, and other quartzose minerals, which I could not refer to any rock. In the neighborhood of the Wahsatch mountains, these minerals again make their appearance; but here they are traceable to a rock which still constitutes a great part of the mountains of this range. The devastation may here be followed step by step. A similar process has been going on in the country of Blue and Green rivers with other strata. The black, soft shale, with gypsum and the strata below it, have disappeared from an immense tract of land. For days before we struck Green river, we travelled over a black, clayish, absolutely sterile soil, produced by the decaying mountains, and in different places, chiefly at a short distance from where we crossed Green river, we found remnants of those strata in buttes of sometimes considerable height, some of them assuming the shape of huge chimneys.

On the foot of the Wahsatch mountains, close to Akanaquint creek, and about a mile from camp 88, a coal measure of an excellent bituminous coal crops out. It rests on sandstone, a thin layer of a brown, soft clay intervening between them, and is about three feet thick on the outcropping.

As soon as we are over the first ridge of the Wahsatch mountains, porphyritic rocks again make their appearance, and their disintegration again gives rise to a better soil and more luxuriant vegetation. These porphyries, from red to dark gray, belong undoubtedly to different periods. One of them erupted, when an oolitic limestone covered the country. At a short distance from our road over the second high ridge, numerous pieces of this limestone may be seen. That the presence of the latter rock in these localities is not merely accidental, is proved by the fact that by contact with the porphyry it has been altered, and has baked together with it. White sandstone, a white, very pure, compact limestone, a greenish and a

red argillaceous limestone, and a sandstone containing mica, are the sedimentary rocks of the Wahsatch mountains in the region of Swambah creek. None of them contain fossils.

A bed of pure crystallized gypsum in the valley of the Ungot-tah-bi-kin creek, deserves to be particularly mentioned. The crystals are imbedded in a red or green marl in such abundance as to form a whole mountain of this valuable mineral. The section of the bed, about a mile from our road, extends about forty feet above the level of the soil, and it has very likely a considerable depth.

In many parts of the Wahsatch and Tuilla mountains, a silicious rock, mostly calcedony and agate, breaks through a gray-white or gray limestone, infiltrating the latter, and forming veins of sometimes considerable thickness. The cañon leading to Swambah creek, and the ridge of the Tuilla mountains east of Cedar creek, consist of this infiltrated limestone.

On Swambah creek I found an extraordinarily large block of crystals, apparently calcareous spar. They were white, semi-transparent, of granular fracture, and consisted of—

Carbonate of lime	93.66
Carbonate of magnesia	4.12
Carbonate of protoxyd of iron	2.02
Water	0.20
	100

To the simple minerals occasionally mentioned heretofore, the following may be added:

Dolomite, found in the valley of Ungot-tah-bi-kin creek.

Hyalite, in the trapp-porphyry of the valleys of Coochetopa creek and Grand river.

Sulphuret of molybdena, in the Wahsatch mountains.

Asphaltum, in different places in the Wahsatch and Tuilla mountains.

Had the Indian difficulties during last winter made geological excursion in Utah Territory admissible, the extraordinarily deep snows of that winter would have made them quite useless, if not impossible. For the same reason, our winter excursion into the Wahsatch mountains and Green river country, resulted quite unproductively in geological facts, and I am not able to add anything new to the geology of that country, as it has been described in former reports, with the exception, however, of a phenomenon which the Great Salt lake offers, and which not only possesses a scientific interest, but may be made of great importance to the development of chemical arts in the valley of the "Saints."

In summer the evaporation of the water of the lake is so great, and the solution of salts becomes so concentrated, that a part of them is deposited on the bottom of the lake. In some places, I have been told, this sediment has been found to be two feet thick. It consists of variable quantities of *sulphate of soda* and chloride of sodium, the sulphate exceeding by far the chloride, at least in the specimens which came under my examination. In the manufacturing of soda, an immense capital is annually wasted in producing this sulphate, which is finally converted into carbonate of soda. It can be had here for the mere trouble of taking it out of the lake.

Another interesting mineral production of the localities around that remarkable lake is found in great quantity at Alum Point, and in other places in Utah Territory. It is the manganesian or feather alum, a mineral of great use in the so-called tawing process, and an excellent material for preserving the skins of birds and other animals. It has rather been considered hitherto as a rare mineral.

The composition of this alum does not seem to be constant; at least not in relation to its proportions of water. I obtained from one specimen 37.25 per cent. sulphuric acid, and 39.45 per cent. of water; and from another 37.26 per cent. sulphuric acid, and only 32.85 per cent. of water. There was no time to complete the analysis.

In the regions between the Tuilla mountains and the Sierra Nevada, the desert character is

not so constantly preserved as in the country east of the Wahsatch mountains, and the soil offers in many places, as far as its chemical composition is concerned, by far more resources. The slopes of the mountains west of the Humboldt mountains are often covered with an excellent soil, producing a good grass, and the want of a more luxuriant vegetation can only be explained by atmospheric and similar influences.

The mountains on the west side of the Great Salt lake have their chief geological features in common with those on the east side. A dark limestone belonging to the coal formation, and above it a conglomerate, resting on porphyritic and granitic rocks, in some places on a silicious shale, constitute the materials out of which they are formed. This limestone as well as the conglomerate, or rather remnants of them, are occasionally met with in many other places travelling westward. The former is one of the main rocks constituting the Humboldt mountains, where it overlies granitic masses. In the northern parts of this mountain range the granite passes gradually into quartz, the latter assuming in some places a shaly structure. It is through limestone that the waters of a subterranean creek in the Humboldt mountains have broken an outlet; and both limestone and conglomerate are often found on the summits of the highest peaks of those regions. A soft shaly rock has almost entirely disappeared from that country, and I found remnants of it only in one single place east of the Humboldt mountains; but the clayish soil, over which we had to travel for days, and which contained a number of small pieces of the rock, led to the belief that it extended once far over the country.

The island mountains in the salt desert immediately west of Great Salt lake consist of granitic and porphyritic rocks; the latter is like most of the porphyries we met with, trachytic, its brownish base dissolving under a lens into small grains and broken crystals melted together. It includes numerous crystals of feldspar and grains of quartz, many half an inch thick, and is very hard.

About a mile and a half from the eastern foot of the Humboldt mountains, about camp 19, (1854,) an interesting phenomenon is presented to the view by a number of warm springs—some forty—all of them lying in a circuit of about a hundred yards in diameter. They rise in tubular channels cut through the granite, most of them having a kind of funnel-shaped reservoir on the surface. The smell of the water and a deposit around the springs, show at once that they contain sulphureted hydrogen, and, although quite tasteless when cooled, the water contains, besides the sulphureted hydrogen, a slight proportion of chlorides and sulphates, as shown by chemical test. The temperature of the water on the surface is about 132° Fahrenheit. The spring we found afterwards in Honey Lake valley seems to have the same chemical composition, but its temperature is at the boiling-point.

The mountains lying between the Humboldt mountains and Humboldt river, by our path, are chiefly composed of quartz rocks, trachytic or dioritic porphyry, the above-mentioned dark limestone and conglomerate, and a soft, white, argillaceous or calcareous sandstone. The most remarkable rock in that country, and which deserves a particular mention, is found around the gorge we came through on the 2d of June, and for which I proposed the name of "Agate cañon." This rock is a compact mixture of minerals of the quartz family—agate, chalcedony, and jasper—and is evidently of igneous origin. To the practical arts it would offer a material which for beauty and hardness can hardly be surpassed.

West of Humboldt river we find quartzose rocks, syenites, and granites, and a soft clay-slate, as the predominating rocks; but the nearer we approach to the Sierra Nevada, the more the so-called volcanic rocks take their place, and at last become the only constituent material of the mountains. In Mud Creek cañon, at the foot of the Sierra, we find for the last time a rock which, by its lithological character, is related to the rock I designated as trapp-porphyry, only that it has become shaly or foliating, by the influence of the surrounding volcanic rocks. In the neighborhood of that cañon I found a rock which has all the appearance of standing between this rock and the trachytes of these regions, and which seems to have been formed by the action of these rocks upon each other.

Leaving the cañon wherea conglomerate of igneous rocks crops out from under the above-described shaly trapp, we no longer meet with any older plutonics, or with any sedimentary rocks. Even sandstone, so abundant in the country we before traversed, has disappeared, and the more recent rocks, basalt, phonolithe, ringing beautifully to the hammer, and chiefly trachytes, with a number of intermediate rocks, become masters of the ground. The trachytic rocks seem to be the predominating, if not the only rocks in those parts of the Sierra which we had to traverse when travelling from the headwaters of the Sacramento river down to Honey Lake valley, and which are covered with the most magnificent pine forests.

The highly interesting scenery around the so-called "Black Butte" bears, of all the parts of the Sierra Nevada we passed over, most strikingly the character of a volcanic country. Surrounded by elevated peaks and high cliffs, and quite isolated, stands a mountain, from eight hundred to a thousand feet high, of conical shape, and formed of black lava, apparently a monument of the latest disturbing forces in these regions. The lava is in some degree decomposed at the surface, and the butte, as well as the soil around, is covered with volcanic sand and blocks or small pieces of that lava. In the cliffs on the west side of the butte, the lava passes gradually into trachyte. The summit of this mountain butte is rounded, and no opening in it is perceptible from below.

On the western slopes of the Sierra we find a granitic trachyte, which is distinguished from all other trachytic rocks of the Sierra we met with. It is a reddish gray rough rock, interspersed with crystals of mica, pyroxene—a crystallized mineral, splinters of which melt before the blow-pipe into a pearl, giving out an intense light—and another transparent substance, on which the blow-pipe has no effect, and which, on closer examination, will very likely prove to be a very brittle quartz. The time allowed to this report unfortunately does not admit of a thorough chemical examination, as well of this as some other interesting rocks described above. It would be of the highest scientific interest to know whether these rocks, and chiefly the trachytes of the Sierra Nevada, conform to the law which in the last few years has been established by Bunsen. The great importance of this law, which seems to explain complicated phenomena in a very simple way, and which is not so generally known as it deserves to be, induces me to give a short exposition of it in this report, and to verify it by such analyses as I have been able to make during the limited time allowed for the preparation of this report.

In the fact, established by him experimentally, that the point at which melted substances become solid, varies according to the pressure exercised on these substances, Bunsen expected to find an explanation for the great variety of eruptive rocks, and for the contradictions in the succession of the crystallization of the several mixing substances in relation to their fusibility. The analyses of rocks in the lump, without separating the different simple minerals of which they are composed, which hitherto have been so much neglected, again become important. The analysis of a great number of the characteristic rocks of Iceland, led to the opinion that all these rocks have originated from separate or combined eruptions out of only two independent hearths. One of these hearths furnished the trachytic, the other one the pyroxenic rocks. Their mixing up gave rise to a series of intermediate rocks, which Bunsen called "trachyto-pyroxenic." Great as may be the difference between their ages, mineralogical character, and arrangement, the trachytic and the pyroxenic rocks show a constant average composition, which has only in a few cases been disturbed by local influences, which are easily traced.*

The first of the extreme members of these rocks, the normal trachytic, is a mixture of bisilicates of alumina and bisilicates of alkalies, the oxygen of the acid to that of the basis being as 3 : 0.596. In the other extreme member, the normal pyroxenic, the proportion between the oxygen of the acid and that of the bases (alumina, lime, magnesia, potash, soda, protoxyd of iron,) is 3 : 1.998, or as 3 : 2, almost. They are to be considered a mixture of bibasic silicates. The proportion between silica and magnesia and lime is almost always constant; but that between alumina and protoxyd of iron is subject to great variations, as shown by analysis.

* Comp. Annual Report by Liebig and Kopp, 1851—1853.

The cause of it is, that such parts as become more easily solid, separate first without the force of crystallization being active. For this reason there are sometimes considerable differences in a rock in short distances. The amount of the variable part changes, however, only slightly. Taking the mean of a great number of analyses, Bunsen gets the composition of the normal trachytic and the normal pyroxenic rocks of Iceland. In the rest, being mixtures of these two, the ratio of the oxygen of the acid to that of the bases varies between the given limits. Their character depends upon these proportions and the physical conditions that ruled their formation. Be S the per cent. of silica in such a mixed rock, be s the per cent. of silica in the normal trachytic, and σ in the normal pyroxenic rock—then $\frac{s-S}{S-\sigma}=a$, where a represents the quantity of normal pyroxenic rock to be mixed with one part of trachytic rock, in order to give the composition of the mixed rock. For the computation of a, B chose the silica, which is easily determined, and by the quantity of silica the quantities of the other parts are also given. Be $p_o, p_1, p_2 \ldots p_n$, the quantities of the single component parts in one part of normal pyroxenic, and $t_o, t_1, t_2 \ldots t_n$, the same in one part of normal trachytic rock, we may then calculate the quantities of the component parts in a mixed rock by the equation—

$$1=\frac{(ap_0+1)}{a+1}+\frac{(ap_1+1)}{a+1}\ldots\ldots+\frac{(ap_n+1)}{a+1}.$$

With the help of this formula all the theoretically possible primitive rocks of Iceland have been calculated and put in tables, and with these theoretical numbers all the analyses of Icelandic rocks agree perfectly; the law holds equally good for the volcanic rocks of Armenia and volcanic rocks generally, and its applicability to the older or plutonic rocks has been put beyond all doubt by the analysis of a great number of granites, sienites, diorites, porphyritic and hornblende rocks, from different countries.

The compositions of the normal trachytic and normal pyroxenic rocks are:

	Norm. trach.	Norm. pyr.
Silica	76.67	48.47
Oxyd of aluminium, Protoxyd of iron	14.23	30.16
Oxyd of calcium	1.44	11.87
Oxyd of magnesium	0.28	6.89
Oxyd of potassium	3.20	0.65
Oxyd of sodium	4.18	1.96
	100.00	100.00

The analysis of a rock from the Sierra Nevada, about 40 miles south of Madelin Pass, gave 50.93 per cent. of silica. According to the first of the above formulas, this rock is a mixture of 1 part of normal trachytic and 10.46 parts of normal pyroxenic rock. The second formula gives its composition as—

Silica	50.93
Protoxyd of iron and alumina	28.77
Oxyd of calcium	10.96
Magnesia	6.31
Oxyd of sodium and potassium	3.03
	100.00

The direct analysis gave:

Silica	50.93
Protoxyd of iron and alumina	29.35
Oxyd of calcium	10.33
Oxyd of magnesium	5.97
Oxyd of sodium and potassium	3.42
	100.00

The following is an analysis of a rock from the headwaters of Pitt river, by Mr. Gustavus Baumgarten, done in my laboratory and under my direction. The determination of silica gave 57.65 per cent.; the rock is a mixture of 1 part normal trachytic, and 2.07 parts of normal pyroxenic rock:

	Composition according to second formula.	Composition found by analysis.
Silica	57.65	57.65
Protoxyd of iron and alumina	24.97	27.56
Oxyd of calcium	8.47	6.53
Oxyd of magnesium	4.74	5.30
Oxyd of sodium and potassium	4.17	2.91
	100.00	100.00

These analyses hardly admit of any doubt as to the applicability of Bunsen's law to the igneous rocks of the Sierra Nevada. It would seem that the hearth of the trachytic masses was lying north, and that of the normal pyroxenic masses more south; a greater number of rocks must, however, be analyzed before we can form a more reliable opinion on that point.

In the Sierra we travelled for days over a red soil, which, according to the popular belief, is gold-bearing. This seems, however, a mistake, produced by the resemblance of its color to that of the soil in the Sacramento valley. It comes from a disintegrated red volcanic rock, of which I found occasionally pieces of six inches in diameter.

There is, however, an auriferous rock, the existence of which in California I find nowhere mentioned, which I found near the summit of one of the high peaks on the Upper Sacramento, (Pitt river.) It is a red rock, with porphyritic structure, and of excessive hardness, bearing unmistakably the signs of gold.

In the rugged Pitt river country, where Canoe creek empties into that river, and a short distance above the mouth of the creek, there is a kind of dam along the creek, made up of a white soil, which, a little remote from the creek, forms a regular stratum of considerable thickness. The rock around is a porphyritic trachyte, and no sedimentary rock of any kind could be detected. On examining this earth under the microscope, I found it to consist of the silicious coats of infusoria, and I therefore sent a specimen of it, together with a specimen of infusorial earth, found in Honey Lake valley, to Professor Bailey, at West Point, as the savan who is best acquainted with American infusoria. According to him they are both made up of diatomaceous shells; some of them are novel, and both are of fresh-water origin, containing many well known species still living all over our country. A fuller description of the new species will be given by Professor Bailey.

I am, sir, very respectfully, your obedient servant,

JAMES SCHIEL, M. D.,

Surgeon and Geologist for Explorations for Central Pacific Railroad Route.

Lieut. E. G. BECKWITH,

3d U. S. Artillery, in charge of Explorations.

List and Description of Organic Remains collected during the Exploration of the Central Pacific Railroad line, by Dr. JAMES SCHIEL, 1853–'54.

Pl. , Fig. 1.—*Fenestella.* Branches slender, bifurcating, with two rows of pores; sometimes but one row; intervals oval or oblong, with rounded angles, and variable in size.

It occurs with *Productus semireticulatus* and *Productus aequicostatus* in the limestone on Willow creek. It might, perhaps, be referred to Fenest. patula of McCoy.

BRACHIOPODA.

Pl. , Fig. 2, *a*, *b*.—*Terebratula subtilita.* Hall, Stansbury's expedition to the Great Salt lake, 409 ; Pl. 4, Figs. 1, 2. Gibbous, obovoid, valves nearly equal; beak of the dorsal valve elevated, incurved, perforated at the apex, mesial depression from centre to front; surface marked with concentric striæ and with faint, radiating striæ.

Occurs with *Productus splendens*, *Spirifer striatus* (?) *Phillipsia*, in the carboniferous limestone about six miles west of Westport. In one specimen the radiating striæ are very distinct.

Pl. , Fig. 3.—*Productus splendens.* Norwood and Pratten. The Producti in the western States, 11; Pl. 1, Fig. 5.

From the same limestone.

Pl. , Fig. 4, *a*, *b*.—*Productus aequicostatus.* Shumard. Large, elongate, dorsal valve much elevated; beak small, passing slightly beyond the cardinal border; surface covered by longitudinal ribs, which bifurcate near the beak, and then continue without further division to the front, the spaces between being occasionally supplied with new ribs. These ribs are slightly sinuous occasionally, but most of them are straight from their origin to their termination.

Occurs with *Fenestella* and *Productus semireticulatus* in the limestone on Willow creek. I have adopted for this shell the name given to it by Dr. Shumard, who kindly furnished me with the above preliminary description from his manuscript on the palæontology of the State of Missouri. A fuller description, and a drawing of a better and more perfect specimen, will be found in his report.

Pl. , Fig. 5.—*Spirifer*, (indet.) Most likely *Sp. striatus*, yet the specimen is too imperfect for description.

Occurs with *Terebratula subtilita* in the limestone near Westport.

CONCHIFERA.

Pl. , Fig. 6.—*Inoceramus*, (indet.) The specimen is only a cast of inoceramus from a yellowish cretaceous limestone near Fort Atkinson.

Pl. , Fig. 7.—*Inoceramus confertim-annulatus.* Roemer, Kreide. Texas, 59. Transverse, ovate, depressed, with concentric ribs and striæ; the spaces between the ribs hardly equal to their width, and marked with regular, equidistant, elevated lines.

I got this inoceramus in Salt Lake City, as coming from the Upper Green River country. It belongs to the cretaceous period.

Pl. , Fig. 8.—*Inoceramus pseudo-mytiloides.* Inequivalved, elongated, with concentric ribs and striæ; anterior part subtruncated; posterior part slightly compressed, with a wing-like extension of the posterior margin against which the striæ are bending.

It occurs in a gray limestone west of Fort Atkinson. The only difference between this shell and Inoc. mytiloides is the bending out of the striæ.

Pl. , Fig. 9.—*Gryphæa Pitcheri.* Shell thick, expanded, distinctly lobed, lower valve convex, upper valve thick and subconvex; beak distinctly incurved. (Morton.)

It was found on the top of a sand-hill near Grand river, where it occurs in great abundance, together with impressions of an ammonites. I am indebted for the determination of this shell to Professor Hall, who has several beautiful specimens in his collection.

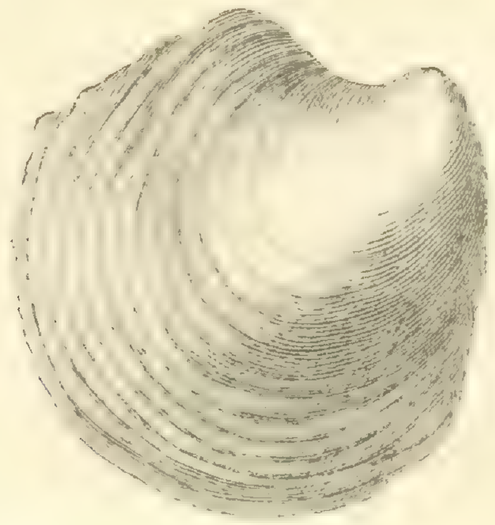


Fig. 10

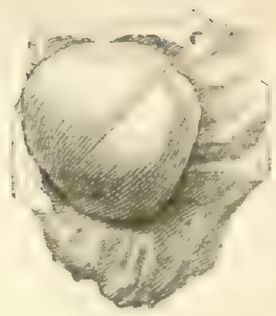


Fig. 8

Fig. 14

Fig. 12

Fig. 5

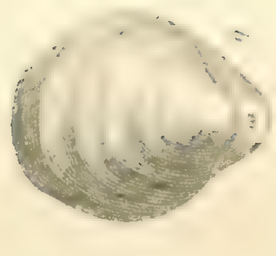


Fig. 11

Fig. 1

Fig. 13

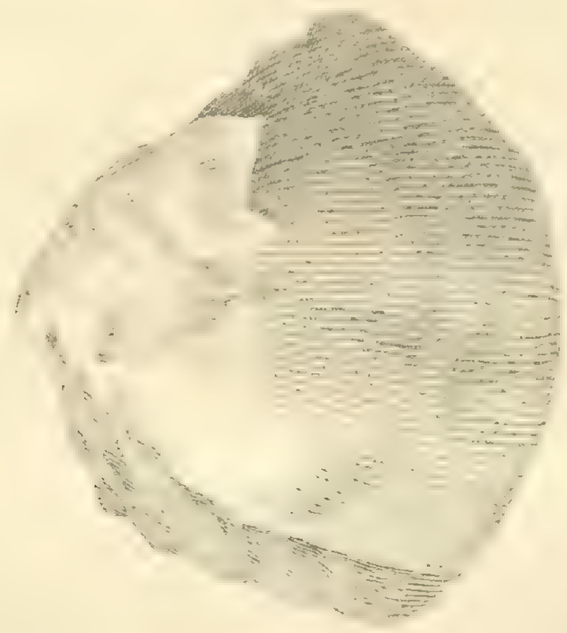


Fig. 4

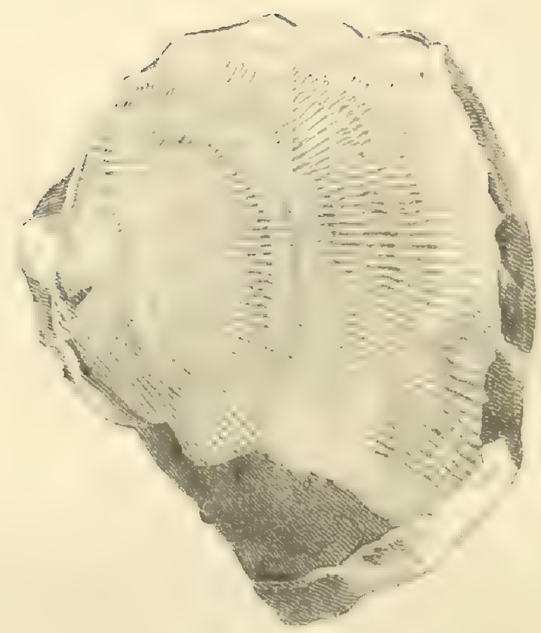


Fig. 5

Fig. 6

Fig. 7

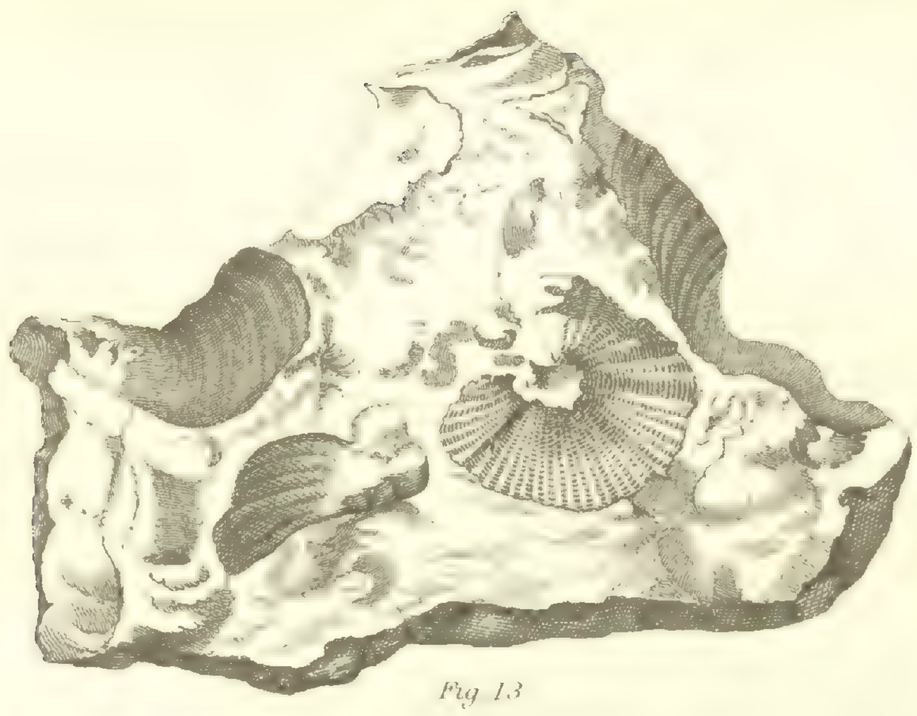


Fig 13

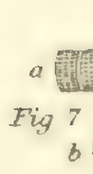


Fig 7

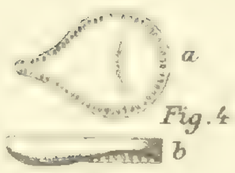


Fig. 4

Fig 1

Fig 9

Fig. 5

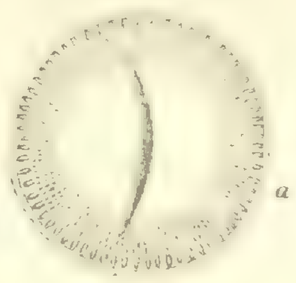


Fig. 2

Fig 6

Fig 3

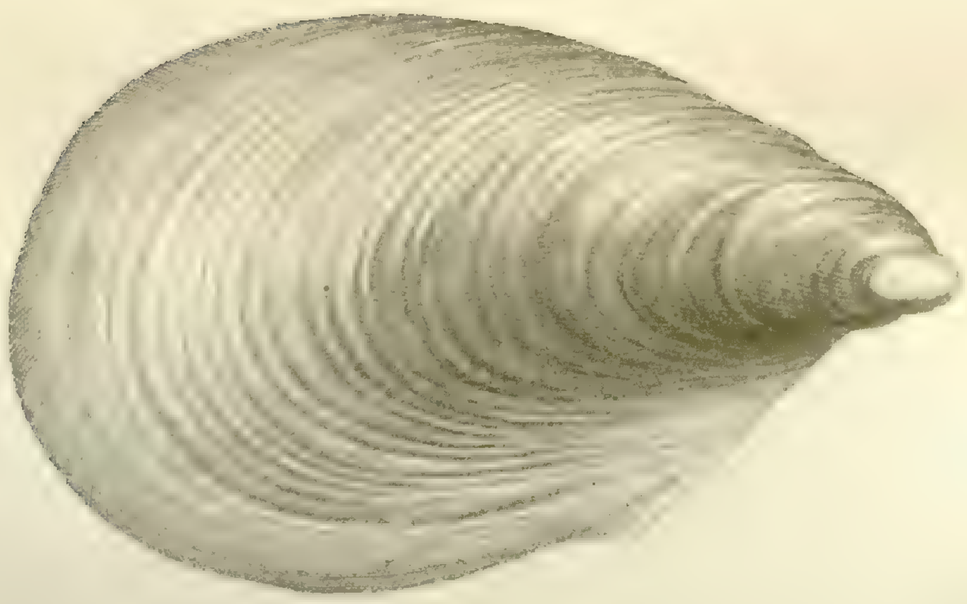


Fig 8

PART OF A FOSSIL FISH FROM THE UPPER GREEN RIVER CRETACEOUS FORMATION

Pl. , Fig. 10.—*Cardium multistriatum.* Shumard. Exploration of the Red river of Louisiana by Marcy and McClellan, 203; Pl. 4, Fig. 2. Shell subrotund, inflated, length and breadth nearly equal, truncated positively, basal and anterior margin rounded; concentric striæ on the surface.

I was given this shell, with the above Inoceramus confertim-annulatus, as coming from the Upper Green river. It belongs to the cretaceous period.

Pl. , Fig. 11 and Fig. 14. Fig. 11.—*Pygidium* of a *Phillipsia.* A new species, from the limestone near Westport, where it occurs with *Terebratula subtilita*, *Productus splendens*, and apparently two other new species of Productus, of which my specimens are too fragmentary to be described. Fig. 14.—*Phillipsia* from a carboniferous limestone west of Indian creek.

Pl. , Fig. 12.—A piece of limestone from Indian creek, the surface being covered with pieces of stems of a species of encrinites and some bryozoa.

Pl. , Fig. 13.—Impression of an ammonites found with Gryphæ Pitcheri on Grand river.

JAMES SCHIEL, M. D.,

Surgeon and Geologist for Explorations for Central Pacific Railroad.

Names and Localities of various Rocks collected by Dr. Schiel *during the Explorations of* 1853.

1. Limestone, fossiliferous; near Westport.
2. Limestone; near Willow creek.
3. Limestone; west from Fort Atkinson.
4. Limestone; west from Fort Atkinson.
5. Limestone, upper; bluff near Bent's Fort.
6. Limestone, lower; bluff near Bent's Fort.
7. Sandstone; Apishpa river.
8. Limestone, upper; near the Rocky mountains.
9. Limestone, lower; near the Rocky mountains.
10. Granite; Huerfano butte.
11. Limestone; Huerfano cañon.
12. White silicate; Rocky mountains.
13. Porphyry; Sangre de Cristo Pass.
14. Porphyry; Sangre de Cristo Pass.
15. Gneiss; Sangre de Cristo Pass.
16. Gneiss; Sangre de Cristo Pass.
17. Mica slate; Roubideau's Pass, Sierra Blanca.
18. Quartz rock; Roubideau's Pass, Sierra Blanca.
19. Quartz rock; Roubideau's Pass, Sierra Blanca.
20. Porphyry; Sahwatch butte; Coochetopa Pass valley.
21. Trapp-porphyry; Sahwatch valley.
22. Trapp-porphyry; Sahwatch valley.
23. Granite; Sahwatch valley.
24. Porphyry; Coochetopa Pass.
25. Trapp-porphyry; Coochetopa Creek valley.
26. Black rock; Coochetopa Creek valley.
27. Granite; Grand river.
28. Silicious shale; Grand river.
29. Mica slate; Grand river.
30. Sandstone; Grand river.
31. Fibrous gypsum; Elk mountains.
32. Silicious shale, with agate.

33. Calcareous spar; White river.
34. Red porphyry; Wahsatch mountains.
35. Gray porphyry; Wahsatch mountains.
36. Hyalite; Grand River valley.
37. Oolitic limestone; Wahsatch mountains.
38. Chalcedony; Wahsatch mountains.
39. Red sandstone; Grand river.
40. Greenish argillaceous limestone; Wahsatch mountains.
41. Grayish-yellow foliating limestone; Wahsatch mountains.
42. Crystallized gypsum; Ungot-tah-bi-kin valley.
43. Greenish limestone; Wahsatch mountains.
44. Chalcedony; Wahsatch mountains.
45. Rock from the towery conglomerate on Grand river.
46. Mica slate; Coochetopa Creek valley.
47. Granite; Coochetopa Creek valley.

Names and Localities of various Rocks collected by Dr. Schiel *during the Explorations of* 1854

I. Granite; Island mountain, Great Salt Lake Desert.
II. Limestone; Humboldt mountains.
III. Shale; east from Humboldt mountains; remnants of stratum.
IV. Altered trapp-porphyry; Coochetopa creek, 1853.
V. Red porphyry; Goshoot mountains.
VI. Conglomerate; first cañon west of Humboldt mountains.
VII. Dioritic porphyry; west of Agate Pass.
VIII. Chalcedony.
IX. Rock from Agate Pass.
X. Cherty rock; Tuilla valley.
XI. Shale; near Humboldt river.
XII. Red quartz; near Humboldt mountains.
XIII. Rock from Agate Pass.
XIV. Dioritic(?) rock; Humboldt mountains, R. R. Pass.
XV. Dioritic(?) rock; west of Humboldt mountains.
XVI. Shaly rock; west of Humboldt mountains.
XVII. Syenite; foot of Sierra Nevada.
XVIII. Gneiss; foot of Sierra Nevada.
XIX. Argillaceous porphyry; foot of Sierra Nevada.
XX. Lava; Black butte.
XXI. Shaly rock; west of Humboldt mountains.
XXII. Shaly trapp-porphyry; foot of Sierra Nevada.
XXIII. Feldspar (violet and white); foot of Sierra Nevada.
XXIV. Silicious rock; west of Humboldt river.
XXV. Basaltic rock; Sierra Nevada.
XXVI. Porphyritic trachyte; Sierra Nevada.
XXVII. Porphyritic trachyte; summit of Madelin Pass, Sierra Nevada.
XXVIII. Trachyte; between Madelin and Noble's Passes, Sierra Nevada.
XXIX. Trachyte; between Madelin and Noble's Passes, Sierra Nevada.
XXX. Trachyte; between Madelin and Noble's Passes, Sierra Nevada.
XXXI. Trachyte; between Madelin and Noble's Passes, Sierra Nevada.
XXXII. Basaltic(?) rock; west from Humboldt mountains.

XXXIII. Basaltic(?) rock; Mud Creek cañon, Sierra Nevada.
XXXIV. Foliating trapp-porphyry; Mud Creek cañon, Sierra Nevada.
XXXV. Granitic trachyte; west of Black butte.
XXXVI. Lava; near Black butte, Sierra Nevada.
XXXVII. Trachyte; upper waters of Sacramento or Pitt river.
XXXVIII. Black silicious rock; near Humboldt river.
XXXIX. Porphyritic trachyte; Sacramento or Pitt river.
XL. Argillaceous porphyry; Sevier river, 1853.
XLI. Granitic porphyry; Granite mountain, Desert near Great Salt lake.
XLII. Granite; Humboldt mountains.
XLIII. Black shale; Sacramento or Pitt river.
XLIV. Gold-bearing quartz; California; presented by Captain Miller, Quartermaster, United States Army.
XLV. Petrified oak block; Cow creek, California; presented by Captain M. S. Miller, Quartermaster, United States Army.

II.—*Letter from Professor* J. W. Bailey *upon Infusorial Fossils submitted to him by Dr. Schiel.*

West Point, N. Y., *December* 14, 1854.

Dear Sir: I have been requested by Dr. Schiel to send to you some drawings of the fossil Diatoms found by him in California. As I have a considerable amount of matter on hand which claims precedence to this, I have only had time to make the accompanying notes and sketches, which can be disposed of as you may think best.

Specimen No. 1.—*Honey Lake Valley.*

This is a fine, grayish white powder, chiefly composed of Diatomaceous shells, all of which are of fresh-water origin, and probably of recent date. The following are the chief species which I have noticed:

Epithemia, allied to E. Westermanni; several varieties of form, perhaps several species. See Figs. 5, 6.

Cocconema asperum, Ehr.
Cocconema cymbiforme, Ehr.
Discoplea atmosphaerica, Ehr.
Surirella campylodiscus, (?) Ehr. Fig. 4, *a*, *b*.
Cocceneis. Fig. 3.
Cymbella gibba, Bailey. Fig. 1.
Cymatopleura (?) Campylodiscus, Bailey. Fig. 2, *a*, *b*.

The last two species I believe to be new, and they may be characterized as follows:

1. *Cymbella gibba.*—Bailey, (Fig. 1.) Bases somewhat triangular, rounded, and very gibbous on the dorsal side, slightly concave on the ventral side. Length, $\frac{2}{1000}$ of an inch; width, about two-thirds of the length. Locality, Honey Lake valley.

2. *Cymatopleura* (?) *Campylodiscus.*—Bailey, (Fig. 2, *a*, *b*.) Bases circular, or sometimes irregularly bent like a Campylodiscus, marked with one deep transverse undulation. Margins strongly striated. Diameter, $\frac{4}{1000}$ to $\frac{5}{1000}$ of an inch. Locality, Honey Lake valley.

Specimen No. 2.—*Junction of Canoe creek and Sacramento river, California.*

A fine, white powder, chiefly composed of a minute species of Galleinella. (See Fig. .)

It is undoubtedly of fresh-water origin, but contains some circular discs so much resembling the marine Actinocycli, that a mistake as to its origin might easily be made. By careful ex-

amination of these discs, however, I have proved them to belong to the genus Stephanodiscus, and have found the crown of thorns preserved on some specimens, although they are commonly broken off. The principal forms I have noticed in this specimen are—

Galleinella (Fig. 7, *a*, *b*) forms chief portion of the mass.
Galleinella varians.
Stephanodiscus—perhaps new.
Pennularia nobilis, Ehr.
Pennularia viridis.
Epithemia, as in No. 1, but comparatively rare.
Surirella splendida (? Ehr.) in fragments.
Pollen of pine.
Spongiolites, which are also present in No. 1.

There are many other fresh-water forms in both specimens, but I have not had time to study them satisfactorily.

Yours, very truly,

J. W. BAILEY.

Lieut. BECKWITH.

APPENDIX.

INSTRUCTIONS FROM THE SECRETARY OF WAR.

WAR DEPARTMENT,
Washington, February 21, 1854.

SIR: Your letter of the 30th of November to the Chief of the Corps of Topographical Engineers has been, by him, submitted to this department, and the following instructions are given for your government.

You are placed in charge of the party commanded by the late Capt. Gunnison, and will carry out the instructions given him by this department, with the following modifications.

By your letter it appears those instructions had been complied with by Capt. Gunnison previous to his death, with the exception of exploring the Weber river and Timpanogos passes or cañons. You will explore and survey those passes, extending your operations eastward to connect with some well known point, ascertained by previous surveys, to be selected by yourself. You will bear in mind that the object of these explorations is the determination of the most practicable railway route to the Pacific; and that you must obtain a profile of the country traversed, by which it will be practicable to show the gradients of the road: that is to say, you must obtain the data for plotting the courses and distances traversed, and the rise and fall of the ground at intervals wherever decided changes occur in the altitude of the surface of the earth above the level of the sea, or above a point the elevation of which is already known.

After completing the explorations and surveys of the two passes above described, you will retrace your steps and survey the route which you propose, passing to the south of the Great Salt lake, in the direction of the "*Sink*" of Humboldt or Mary's river, thence towards Mud lake and across to the tributaries of Feather river, and thence by the most practicable route to the valley of the Sacramento river; provided that the three conditions hereafter stated can be complied with:

First. If you have money enough left from the sum assigned the late Capt. Gunnison, after completing the surveys already ordered. That amount was $40,000; and a statement from this department is herewith sent you, showing what portion of it had been drawn by Capt. Gunnison at his death.

Second. If, after the completion of the surveys of the Weber river and Timpanogos, you will have remaining, in good condition, the instruments necessary to make the explorations and surveys in the manner which has been described to you as necessary, more particularly the instruments necessary to obtain the data to make the profiles of the country traversed.

Third. Provided you can employ an armed force necessary to supply the place of that which has been removed by the massacre of Capt. Gunnison; and which, in addition to that already employed, and the military escort under command of Capt. Morris, will be sufficient to enable you to make your surveys with security from the Great Basin to the settlements in California.

It is presumed you would not have suggested a survey of the route by Mud lake and Feather river but upon information which leads you to suppose it a practicable one for a railway. If the conditions above stated are complied with, and you make the explorations, Capt. Morris is hereby directed to escort you, and you will make a requisition on him to that effect. On arriving in California you will disband your party, sell your public property, and return by sea, with your assistants, to Washington city.

Should it, however, be determined, by the conditions above stated, not to make the exploration across the Great Basin and the Sierra Nevada, you will extend the exploration of the Weber river and Timpanogos passes eastward to Fort Leavenworth, through the coal basin in the vicinity of Currant creek and Bishop mountain, as delineated on Stansbury's map, or by some route which has not been surveyed. On reaching Fort Leavenworth you will discharge your party and return to this city.

On the receipt of this, you will forward to this department, by the first opportunity, duplicates of all the maps and notes of surveys of the late Capt. Gunnison, and retain the originals until your return to Washington city.

You will, at convenient times, send duplicates of your own notes and surveys to this department.

To enable you to comply with these conditions, you are authorized to draw on this department for twenty-three thousand dollars, the balance unexpended of that portion of the appropriation assigned to the late Capt. Gunnison.

You will not exceed this amount in your expenditures, and you will forward your account to the Colonel of Topographical Engineers.

Very respectfully, your obedient servant,

JEFF'N DAVIS,
Secretary of War.

Lieut. E. G. BECKWITH,
U. S. Army, Great Salt Lake City, Utah Territory.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

REPORT

ON THE

BOTANY OF THE EXPEDITION:

BY

JOHN TORREY AND ASA GRAY.

ROUTE ON THE FORTY-FIRST PARALLEL OF NORTH LATITUDE, UNDER THE COMMAND OF LIEUT. E. G. BECKWITH, THIRD ARTILLERY;

AND

ROUTE NEAR THE THIRTY-EIGHTH AND THIRTY-NINTH PARALLELS OF NORTH LATITUDE, UNDER THE COMMAND OF CAPT. J. W. GUNNISON, CORPS OF TOPOGRAPHICAL ENGINEERS.

CONTENTS.

PART I.

Page.

Plants collected by Mr. James A. Snyder, under the direction of Lieut. E. G. Beckwith, U. S. A., in an expedition made under his charge from Great Salt Lake, Utah Territory, directly west to the Sacramento valley, in California, in the months of May, June, and July, 1854 - - - - - - - - - - - - - - - - 119

PART II.

Plants collected by Mr. F. Creutzfeldt, under the direction of Capt. J. W. Gunnison, U. . A., in charge of explorations for a railroad from Fort Leavenworth, via the Kansas, Arkansas, and Huerfano rivers, the Sangre de Cristo Pass, San Luis valley, Coochetopa Pass, Grand and Green rivers, and thence into the Great Basin, in the vicinity of the Sevier or Nicollet lake. The collection was made from early in June to late in October, 1853 - - - - 125

BOTANICAL REPORT.

Botanical Report, by JOHN TORREY *and* ASA GRAY, *upon the Collections made by Captain* GUNNISON, *Topographical Engineers, in* 1853, *and by Lieutenant* E. G. BECKWITH, *Third Artillery, in* 1854.

I.—Plants collected by Mr. James A. Snyder, under the direction of Lieutenant E. G. Beckwith, U. S. A., in an expedition made under his charge from Great Salt Lake, Utah Territory, directly west to the Sacramento valley, in California, in the months of May, June, and July, 1854.

II.—Plants collected by Mr. F. Creutzfeldt, under the direction of Captain J. W. Gunnison, U. S. A., in charge of explorations for a railroad from Fort Leavenworth, *via* the Kansas, Arkansas, and Huerfano rivers, the Sangre de Cristo Pass, San Luis valley, Coochetopa Pass, Grand and Green rivers, and thence into the Great Basin, in the vicinity of the Sevier or Nicollet lake. The collection was made from early in June to late in October, 1853.

PART I.

Plants collected by Mr. JAMES A. SNYDER, *under the direction of Lieutenant* E. G. BECKWITH, *U. S. Army, in an expedition made under his charge from Great Salt lake, directly west, to the Sacramento valley, in California, in the months of May, June, and July,* 1854.

AQUILEGIA CANADENSIS, *Linn.; Torrey and Gray, Fl.* 1, *p.* 29. In a cañon east of the Sierra Nevada; June 17. Few phanerogamous plants of this country have so great a geographical range as has this species, (including the A. formosa, *Fischer*,) namely: from Hudson's Bay to Florida and New Mexico, and from Unalaschka to California.

DELPHINIUM MENZIESII, *DC. Syst.* 1, *p.* 355; *Hook. Fl. Bor.-Amer.* 1, *p.* 25. Near Great Salt Lake. Also, in a valley of the Sierra Nevada; with an incomplete specimen of what may be a white-flowered variety; May and June.

ESCHSCHOLTZIA CALIFORNICA, *Cham. and Nees, Flor. Phys. Berol. p.* 73, *t.* 15, *non Lindl.* Sierra Nevada; June 25.

TURRITIS RETROFRACTA, *Hook. Fl. Bor.-Amer.* 1, *p.* 41. Summit of a mountain in the Great Basin east of the Sierra Nevada. In flower only; June 1.

ERYSIMUM ASPERUM, *DC.; Torr. and Gray, Fl.* 1, *p.* 95. Mountains near Great Salt Lake; May.

SPRAGUEA UMBELLATA, *Torr. Pl. Fremont, in Smithson. Contrib. p.* 4, *t.* 1. Summit of Noble's Pass, Sierra Nevada; July 3. The specimens of this interesting Portulacaceous genus accord with those of Col. Fremont, who alone has gathered the plant hitherto; but being younger, the corollas are more conspicuous, and the scarious sepals not so large.

LEWISIA REDIVIVA, *Pursh, Fl.* 1, *p.* 368; *Hook. and Arn. Bot. Beech. p.* 334, *t.* 86. On the Sierra Nevada; June 25.

SIDALCEA MALVÆFLORA, *Gray, Pl. Wright.* 1, *p.* 16. Mountains east of the Sierra Nevada; June 14.

VIOLA BECKWITHII, (n. sp.): subcaulescent; ascending stems abbreviated; cauline leaves biternately or pedately parted, decurrent on the margined petiole, the lobes or segments oblong-linear, hirsute-puberulent; stipules minute, scarious, entire; sepals linear, obtuse, ciliolate; lower petal barely saccate at the base, purple, with yellow claws, the two upper shorter and deep violet. On the slope of a mountain between Great Salt Lake and the Sierra Nevada;

June 1. A well-marked species; with the foliage somewhat like that of V. delphinifolia, *Nutt.;* but the primary divisions compoundly divided in a ternate or pinnatisect manner; and there is a distinct stem, although it is only an inch long in the specimen. Lobes of the leaves half an inch or less in length. Stipules very small and inconspicuous, except those of the lowest and subradical leaves, which are larger. Peduncles 2 inches, naked. Petals half an inch long. Style short, clavate, minutely bearded at the gibbous summit; the stigma lateral.

Trifolium altissimum, *Dougl. in Hook. Fl. Bor.-Am.* 1, *p.* 130, *t.* 48. On the Sierra Nevada; June 22.

Astragalus (Phaca) Purshii, *Dougl. in Hook. Fl. Bor.-Am.* 1, *p.* 152. Phaca mollissima, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 350; *Torr. in Stansbury's Rep. p.* 385, *t.* 3, *figs.* 4 and 5. Near Humboldt river; in fruit. In reuniting Phaca to Astragalus, the name given by Douglas to this species is to be restored, both on account of its priority, and because there is already an Astragalus mollissimus.

Astragalus (Phaca) Utahensis: caespitose, very softly and densely white-tomentose; stems short and depressed; leaflets 6–9 pairs, broadly obovate or nearly orbicular; stipules lanceolate, subulate-pointed, free; peduncles equalling or exceeding the leaves, subcapitately 3–6-flowered; bracts setaceous, twice the length of the pedicels; teeth of calyx subulate, much shorter than the cylindrical tube; corolla violet-purple; legumes extremely woolly, sessile, oblong, pointed, incurved, strictly one-celled. Phaca mollissima *β.* Utahensis, *Torr. in Stansb. Rep. p.* 385, *t.* 2. Near Lone Rock, south of Great Salt Lake. In flower; May. Although closely allied to the preceding, this may safely be considered as a distinct species; and so Dr. Torrey was inclined to regard it. A. Purshii, besides its oblong and often acute or acutish leaflets, has the foliage and calyx, &c., clothed with villous or shaggy hairs, so that Hooker describes it as "hirsutissimus," and the flowers are said by Douglas to be yellow, meaning doubtless ochroleucous, except a purple tip to the keel. The present plant is white, with a soft and matted tomentum, and the corolla is violet-purple. The mature pods, (here described chiefly from a fruiting plant gathered by Captain Stansbury, which is doubtless a form of the species, though with shorter peduncles,) after detaching the thick mass of wool in which they are imbedded, are found to be narrower, but otherwise similar to those of the preceding. In the figure above cited, the tube of the calyx is mostly represented quite too short. It is really of the same elongated form as in A. Purshii, but the teeth are not so setaceous.

Astragalus (Homalobus?) Beckwithii, (n. sp.): glabrous or nearly so, low, perennial; stems branched from the base, ascending; stipules triangular-lanceolate, nearly free; petioles slender; leaflets 6–9 pairs, small, oval-orbicular, rather scattered; peduncles about the length of the leaves, 7–8-flowered; bracts subulate, small; calyx oblong-campanulate, sparsely and minutely black-haired; the aristiform-subulate teeth nearly as long as the tube; corolla ochroleucous, incurved, the oblong vexillum deeply emarginate; ovary linear, stipitate. On the Cedar Mountains, west of Lone Rock, and south of Great Salt Lake; May; in flower. The slender stems, with the peduncles that terminate them, are only 4 inches long in the specimen, and not exceeding the radical leaves; but as they go on to branch they doubtless attain a considerably greater height in the season. Leaflets $2\frac{1}{2}$ or 3 lines long, slightly petiolulate, rather fleshy in texture, veinless, glabrous, except some minute hairs on the midrib and margins when first developed. Flowers crowded on very short pedicels; tube of the calyx 3 lines long; corolla 9 lines long, abruptly curved near the obtuse tip of the keel, which is much shorter than the wings and vexillum; ovary glabrous, more or less compressed, many-ovuled, neither suture at all introflexed, raised on a stipe which is soon about as long as the tube of the calyx. The fruit, unfortunately, is still unknown; but the plant is evidently one not before described.

Astragalus diphysus, *Gray, Pl. Fendl. p.* 34? Southwest of Great Salt Lake; May. In flower only, and not to be accurately determined.

LUPINUS AFFINIS, *Agardh, Syn. Lup. p.* 20; *Torr. and Gray, Fl. p.* 376. Agate Pass of the Quartz Mountains; June 1.

LUPINUS DECUMBENS, var. ARGOPHYLLUS, *Gray, Pl. Fendl. p.* 38. Utah, in a cañon; May 29. Flowers yellow and white. This is the same as Fendler's No. 167, and is very likely Pursh's L. argenteus. L. laxiflorus, perhaps, runs into it. The calyx is conspicuously saccate-spurred on the upper side.

ROSA GYMNOCARPA, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 461. On the Sierra Nevada; July.

ŒNOTHERA MARGINATA, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 500. On the summit of the Humboldt Mountains, Utah; May.

ŒNOTHERA (CHYLISMIA) CLAVÆFORMIS, *Torr. in Frem. Rep. 2d Exped. p.* 314. At the foot of the Sierra Nevada, on the eastern side; June. What appears to be a cinereous and somewhat hairy, more caulescent, and branching variety of this, was gathered by Coulter: No. 180 of his California collection.

ŒNOTHERA (SPHÆROSTIGMA) ALYSSOIDES, *Hook. and Arn. Bot. Beech. p.* 394; *Hook. Ic. Pl. t.* 339. Near Humboldt river; June. Flowers white.

ŒNOTHERA (PRIMULOPSIS) TANACETIFOLIA (n. sp.): stemless, perennial? minutely pubescent; leaves lanceolate in outline, interruptedly pinnately parted into very numerous small segments, some of them minute and oval or oblong, the others linear; all sinuate-toothed or pinnatifid; tube of the calyx shorter than the leaves, filiform, dilated at the summit; the segments lanceolate, shorter than the obovate petals and the style; anthers oblong, much shorter than the moderately unequal filaments; stigma discoid, entire. On the higher parts of the Sierra Nevada; June 18. Root apparently thick and perennial. Leaves 3 or 4 inches long, including the short petiole, 5 to 8 lines wide, finely dissected. Tube of the calyx 2 inches or more in length; the segments half an inch long. Petals bright yellow, nearly an inch long. Stigma broad and flat. Fruit not seen.

ŒNOTHERA (GODETIA) RUBICUNDA, *Lindl. Bot. Reg. t.* 1856. In the Sierra Nevada; June.

PEUCEDANUM NUDICAULE, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 627, var. ELLIPTICUM. Minutely and softly pubescent; fruit narrowly elliptical, nearly three times as long as broad, the winged margin as wide as the disk. Round Valley, near the sources of the Sacramento, in the Sierra Nevada; June 27. Intermediate between P. nudicaule and P. macrocarpum, having exactly the foliage of the former and the fruit of the latter. The roots of this species are used as food by the natives.

PEUCEDANUM TRITERNATUM, *Nutt. in Torr. and Gray, Fl. l. c.* Seseli biternatum, *Pursh, Fl.* 1, *p.* 197; *Hook. Fl. Bor.-Amer.* 1, *p.* 304, *t.* 94. Sierra Nevada. The roots of this plant, in a dried state, were brought home by Lieutenant Beckwith. They are about the size of "peanuts," and are collected very largely by the Indians. When dried they are hard but brittle, and have a mild sweet taste. They afford a good proportion of the food of some tribes. Besides a large quantity of starch, they contain much other nutritious matter.

CYMOPTERUS MONTANUS, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 624; *Gray, Pl. Fendl. p.* 67. Summit of the Goshoot Mountain, Central Utah. In the solitary specimen which the collection contained, the flowers are in a singular abnormal condition. The upper part of the ovary is furnished with ten spongy wings, which extend beyond the flower. The stamens are reduced to rudiments. The teeth of the calyx are normal. Instead of five petals there are only two or three, and these are of an unusual form. The styles are conspicuous, but seem to be destitute of stigmas.

CHÆNACTIS STEVIOIDES, *Hook. and Arn. Bot. Beech. p.* 371. Foot of the Sierra Nevada, on the eastern side; June.

LAYIA GLANDULOSA, *Hook. and Arn. Bot. Beech. p.* 358. Eastern side of the Sierra Nevada; June. Rays white.

TETRADYMIA GLABRATA (n. sp.): shrubby, divaricately branched, unarmed, young branchlets, and foliage loosely clothed with floccose white wool, which is soon deciduous; leaves subulate or acerose, rather fleshy; the primary ones erect (none of them converted into spines); the secondary ones crowded in axillary fasciales, glabrous; scales of the tomentose-canescent involucre and flowers four; hairs of the achenium much shorter than the barbellate-denticulate bristles of the pappus. On the Sierra Nevada, June 16. This is distinguished from T. Nuttallii by the acerose, terete, or angled and fleshy leaves, mostly mucronate or pointed, and glabrous, or soon glabrate: from T. spinosa (which it resembles in the secondary leaves) by the fewer flowers and involucral scales, the hairs of the ovarium much shorter than the pappus, &c.; and from both of the entire want of spines. It belongs to Tetradymia proper.

DODECATHEON INTEGRIFOLIUM, *Hook. Fl. Bor.-Am.* 2, *p.* 118; *and Bot. Mag. t.* 3622. In a cañon between Salt Lake and the Sierra Nevada; May.

PHLOX CANESCENS (n. sp.): dwarf, very much branched, and densely caespitose, tomentose when young, and canescent; leaves acerose, imbricated, at length recurved-spreading, not rigid, very woolly towards the base, the lower ones marcescent; flowers sessile; teeth of the calyx similar to the leaves, and fully as long as the woolly tube; tube of the corolla much longer than the calyx and the cuneiform obovate retuse lobes. P. Hoodii, *Torr. in Stansb. Exped. p.* 304. On the Cedar Mountains, south of the Great Salt Lake. This species (of which badly preserved specimens were also gathered by Colonel Fremont, in his second expedition) is allied to P. Hoodii and P. Douglasii. From the former it is distinguished by its more slender leaves and calyx-lobes, and much longer corolla; from the latter (which has longer calyx-teeth than is shown in Hooker's figure) it is distinguished by its woolliness, its less rigid foliage, longer calyx-lobes, and smaller corolla, but with the tube proportionally longer. The ovules are solitary in each cell. The limb of the corolla appears to be white; its tube yellowish.

GILIA PULCHELLA, *Dougl. in Hook. Fl. Bor.-Amer.* 2, *p.* 74. At the foot of the Humboldt Mountains, on the eastern side; May.

PHACELIA INTEGRIFOLIA, *Torr. in Am. Lyc. Nat. Hist. N. Y.* 2, *p.* 222, *t.* 3. Valley of Humboldt River, Utah; June 8.

PHACELIA HUMILIS (n. sp.): annual, low, much branched from the base; leaves oblong, spatulate or lanceolate, all simple and entire, indistinctly veined, minutely hirsute-pubescent like the branches, and glandular dotted; racemes densely-flowered; segments of the calyx linear, obtuse, hispid, a little shorter than the (deep violet-colored) corolla; stamens exerted. Near the summit of the Sierra Nevada, California; June. A well-marked species, three or four inches high, somewhat cinereous, with a fine pubescence, except the inflorescence, and especially the calyx, which is hispid with rigid white hairs. Leaves an inch or less in length, short-petioled. Corolla short, when expanded three lines in diameter; the base biplicate between the stamens. Filaments sparingly hispid above. Style glabrous. Ovules two in each cell. Capsule 2–3-seeded. This can hardly be the P. canescens of Nuttall, in Pl. Gambell., which accords better with some states of P. circinata.

SCROPHULARIA NODOSA, *Linn.; Benth. Pl. Hartweg. no.* 1877. Foot of the Sierra Nevada; June. The leaves are smaller, much truncate at the base, and more laciniate-toothed than the plant of the Atlantic States.

COLLINSIA PARVIFLORA, *Dougl. in Lindl. Bot. Reg. t.* 1802. Foot of the Humboldt Mountains; May.

PENTSTEMON SPECIOSUS, *Dougl. in Lindl. Bot. Reg. t.* 1270. Mountains in the western part of Utah; June.

PENTSTEMON HETEROPHYLLUS, *Lindl. Bot. Reg. t.* 1899? Sierra Nevada, California, on the summit of the mountains; June. Two forms, if not species, have been merged by Hooker and

Arnott under P. heterophyllus. The present single specimen resembles the var. *α*, in the narrow and marginless sepals, and in the smaller flowers; but the peduncles are principally three-flowered. Not improbably it belongs to an entirely different species.

PENTSTEMON HETERANDRUM (n. sp.): glabrous; stem slender, virgate; leaves lanceolate or oblong-linear, obtuse, callose-serrulate, obtuse or subauriculate at the base; panicle spicate, interrupted; cymes subsessile, several-flowered; calyx puberulous, the segments ovate-lanceolate; corolla (nearly white) infundibuliform, slightly gibbous above, with 5 short subequal lobes, in æstivation various; stamens glabrous, straightish, of nearly equal length, all antheriferous, or the fifth without an anther. Sierra Nevada, California; June 30. Flower white, with pink lines half an inch in length. Cauline leaves an inch long, and 3 lines wide; the floral ones successively reduced to small bracts. Anthers glabrous; the cells distinct, moderately diverging. Stigma minute and simple. Ovary, &c., apparently as in Pentstemon. Fruit not seen. Two peculiarities are to be noticed in this remarkable plant, either of which would have been sufficient to exclude it from Pentstemon, but both prove to be inconstant in the species. One of these relates to the stamens, which, in the flowers examined, were perhaps more frequently completely *pentandrous* than otherwise; the fifth (posterior) filament being similar to the others, and bearing either an exactly similar anther, or sometimes one with rather smaller cells, and with the filament or connective prolonged into a short and blunt apical appendage, as shown in figures 9 and 10. In some flowers, however, this anther was found to be reduced to a single and rather imperfect cell, and a bare rudiment of the second cell, as in fig. 11; in others again, (as in fig. 12 and fig. 6,) the fifth stamen is wholly destitute of any trace of anther, as in Pentstemon universally, with this exception, if such it be. It is also to be noted that the stamens of this plant are nearly equal in length, at least when all five are antheriferous, and that they are inserted into the very base of the corolla. The remaining peculiarity relates to the æstivation of the corolla; in which, although some of the flower-buds plainly have the two posterior lobes, or one of them, exterior to the others, in the manner of the Antirrhinideæ generally, (this being, indeed, the only absolute character of that suborder), as shown in figures 3 and 4; yet, in quite as many instances we find the lateral lobes exterior in the bud, and covering the two posterior as well as the anterior, (as is represented in figure 2), in the manner of the Rhinanthideæ: a new and striking instance of the instability of the modes of æstivation of the corolla, and one not altogether unexpected, since Mr. H. T. Clark, a former pupil of Dr. Gray, and an acute and zealous naturalist, showed him several years ago that both modes occur in Mimulus ringens, M. moschatus, &c.

MIMULUS LUTEUS, *Linn.* In the Sierra Nevada; June.

CASTILLEJA HISPIDA, *Benth. in Hook. Fl. Bor.-Amer.* 2, *p.* 105. Cedar Mountains, south of Great Salt Lake; May.

CASTILLEJA PALLIDA, *Kunth.* Foot of the Humboldt Mountains, on the eastern side; May.

AUDIBERTIA INCANA, *Benth. in Bot. Reg. t.* 1469; *and in DC. Prodr.* 12, *p.* 359. On the Sierra Nevada; June 20. Flowers blue.

MONARDELLA ODORATISSIMA, *Benth. Lab. p.* 332; *and in DC. Prodr.* 12, *p.* 190. *β.* GLABRIUSCULA; nearly glabrous; branches slender; leaves oblong-lanceolate, narrowed to a petiole at the base, rather acute; heads terminal; bracts ovate, (colored,) shorter than the calyx, rather acute; teeth of the calyx ovate-lanceolate, acute, unarmed. Sierra Nevada; July 8. Differs from M. odoratissima in its larger and conspicuously petiolate leaves, and in the narrower acutish bracts, &c. Flowers rose-colored.

Most of the species of this genus have the narrow lobes of the corolla sacculate at the apex; a character which seems to have escaped the notice of Mr. Bentham.

MERTENSIA OBLONGIFOLIA, *G. Don, Syst. Gard.* 4, *p.* 372; *DC. Prodr.* 10, *p.* 92. Pulmonaria oblongifolia, *Nutt. in Journ. Acad. Phil.* 7. *p.* 13. Pass in Humboldt Mountains; May 23. Flowers blue. This species was found also in various parts of Utah, by Colonel Fremont.

ERITRICHIUM GLOMERATUM, *DC. Prodr.* 10, *p.* 131. Myosotis glomerata, *Nutt. Gen.* 1, *p.* 112; *Hook. Fl. Bor.-Amer.* 2, *p.* 82, *t.* 162. Summit of Humboldt Mountains; May 27.

ECHINOSPERMUM FLORIBUNDUM, *Lehm. Pug.* 2, *p.* 24; *Hook. Fl. Bor.-Amer.* 2, *p.* 84 *t.* 164; *DC. Prodr.* 10, *p.* 143. Summit of Humboldt Mountains; May 27. Corolla white, finely veined with blue.

GRAYIA POLYGALOIDES, *Hook. and Arn. in Hook. Ic. t.* 271 *and* 388; *Bot. Beech. p.* 387. G. spinosa, *Moq. in DC. Prodr.* 13, *pars* 2, *p.* 119. Chenopodium (?) spinosum, *Hook. Fl. Bor.-Amer.* 2, *p.* 127. Eastern base of the Sierra Nevada; June 15, (in fruit.) This shrub is called *Greasewood* by the hunters.

EUROTIA LANATA, *Moq. Chenop. p.* 81; *and in DC. Prodr.* 13, *pars* 2, *p.* 121. Diotis lanata, *Pursh, Fl.* 2, *p.* 602; *Nutt. Gen.* 2, *p.* 206. Eastern base of the Sierra Nevada; June 15. Flowers monoecious and dioecious. Sepals of ♂ ovate, or rather acute. Moquin (l. c.) asks whether the ♀ flowers are not bibracteate and destitute of a calyx. This is no doubt their true structure, and is the view taken of them by Ledebour, (*Fl. Ross.* 3, *p.* 737.)

ERIOGONUM OVALIFOLIUM, *Nutt. in Journ. Acad. Sc. Phil.* 7, *p.* 51, *t.* 8, *fig.* 1. Eucycla ovalifolia, *Nutt. l. c.* (*n. ser.*) 1, *p.* 166. Eastern base of the Sierra Nevada; June 15. In our solitary specimen there is but a single scape, which is about seven inches high. The leaves are broader than in Nuttall's plant. The filaments are scarcely one-third the length of the sepals, and woolly.

ERIOGONUM CERNUUM, *Nutt. in Journ. Acad. Sc. Phil.* (*new ser.*) 1, *p.* 162, *β.* PURPURASCENS. Eastern base of the Sierra Nevada; June 16. Leaves sometimes almost reniform-orbicular. Scape sparingly and trichotomously branching an inch or two above the base. Peduncles purplish, and involucres glandularly pubescent. Sepals deep rose-color, with pale margins, the exterior ones somewhat retuse, much longer and broader than the inner ones. Filaments shorter than the inner sepals, glabrous. Achenium with a long acuminate point. Embryo curved, the radicle elongated, erect. Differs from the ordinary form of E. cernuum, which is much more branched, and has white flowers.

RUMEX VENOSUS, *Pursh, Fl.* 2, *p.* 733; *Nutt. Gen.* 1, *p.* 240; *Hook. Fl. Bor.-Amer.* 2, *p.* 130, *t.* 174. Mountains in Central Utah, May 12.

AMIANTHIUM NUTTALLII, *Gray, in Ann. Lyc. N. York,* 4, *p.* 123. Helonias augustifolia, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 5, *p.* 154. Amiantanthus Nuttallii, *Kunth,* 4, *p.* 181. Foot of Oquirrh Mountain, south end of the Great Salt Lake; May 6.

SISYRINCHIUM GRANDIFLORUM, *Dougl. in Bot. Reg. t.* 1364; *Bot. Mag. t.* 3509; *Hook. Fl. Bor.-Am.* 2. *p.* 207. Pass of Humboldt Mountain; May 23.

IRIS LONGIPETALA, *Herbert in Hook. and Arn. Bot. Beech. p.* 395. Fort of Humboldt Mountains on the east side; May 28.

CAMASSIA ESCULENTA, *Lindl. Bot. Mag. t.* 1486; *Kunth. Enum.* 4, *p.* 347; *Torr. and Gray in Whipple's Report, ined.* Phalangium Quamash, *Pursh, Fl.* 1, *p.* 226. Near the summit of the Sierra Nevada; June 18.

CALOCHORTUS NUTTALLII: stem 2-flowered; leaves very narrowly linear; petals obovate-cuneate, rounded at the summit (white, but yellow at the base), with an oblong dense tuft of hairs on the claw; and just above this a purple spot, with a few scattered hairs. C. luteus, *Nutt. in Journ. Acad. Philad.* 7, *p.* 51, *not of Dougl.* Summit of Noble's Pass, Sierra Nevada; July 3. We have little doubt of this being Nuttall's C. luteus, as it agrees exactly with his description, and with an imperfect but original specimen of that plant, except that the flower, according to Snyder, is white. Mr. N. was uncertain of the color of the flower in his specimen, for he says they are "apparently sulphur yellow." They are, indeed, yellow at the base even in the dried plant, and Mr. Nuttall supposed they were wholly of that color in the fresh state. The marking and other characters of the petals are unlike those of Douglas's C. luteus; and

as his plant was first discovered, and probably first described, the name must be retained for it. Besides, the name given to it by Mr. Nuttall is inappropriate, if, as we feel pretty confident, the flower of his plant is white.

BRODIÆA GRANDIFLORA, *J. E. Smith in Linn. Trans.* 10, *p.* 3; *Kunth, Enum.* 4, *p.* 471. Scape glabrous; umbel, few-(8–12-) flowered; the rays usually 2–4 times longer than the flowers; abortive stamens linear, emarginate, and often also mucronate; cells of the ovary about 10-ovuled. Madelin Pass of the Sierra Nevada; June 26.

BRODIÆA PARVIFLORA, n. sp.: scape roughish; umbel, many-(15–20-) flowered; pedicels shorter than the flower; sterile stamens ovate-lanceolate, rather acute, entire; cells of the ovary 6–8-ovuled. With the preceding; June 26. Bulb ovate, sometimes more than an inch in diameter. Leaves all radical or nearly so, rather shorter than the scape, about two lines wide, smooth. Scape scarcely larger than a crow-quill, the upper part somewhat flexuous, terete, scabrous with very minute points. Umbel about an inch and a half in diameter; pedicels unequal, most of them scarcely half the length of the flowers. Involucrate bracts, 4–8, colored, about as long as the pedicels, the outer ones ovate and acuminate. Flowers about half an inch long, pale purple, the tube somewhat inflated; segments erect, ovate, rather acute. Fertile stamens 3, inserted at the upper part of the tube of the perianth, opposite the inner segments; anthers linear-oblong, acute at each end. Style filiform; stigma dilated, 3-lobed, the lobes fimbrillate-papillose. We have long had specimens of this plant, collected by Colonel Fremont on Prevost's Fork of the Utah; and others brought from the valley of the Sacramento by Dr. Stillman. It is easily distinguished from B. grandiflora by the characters given above.

PTERIS AQUILINA, *Linn.; Torr. Fl. N. York*, 2, *p.* 488. On the Sierra Nevada.

PART II.

Plants collected by Mr. F. CREUTZFELDT, *under the direction of Captain* J. W. GUNNISON, *U. S. Army, in charge of explorations for a railroad from Fort Leavenworth, by the way of the Kansas and Arkansas rivers, to Bent's Fort; thence by the Huerfano river and Sangre de Cristo Pass to the valley of San Luis; thence west from that valley to Grand and Green rivers; thence into the Great Basin, Utah, to the vicinity of the Sevier or Nicollet lake. The collection was commenced at Westport, in Missouri, in June,* 1853, *and finished late in October.*

[The Rocky mountain ranges were entered early in August. The Sierra Blanca, in which the Sangre de Cristo and Roubideau's passes are found, forms the eastern range of the Rocky mountains, and (at the head of San Luis valley, New Mexico) unites with the next western range, which is known as the Sierra San Juan or Sahwatch chain. This sierra, in turn, is joined around the head of Grand river to Elk mountain, and this again to the Roan mountains, the latter being only separated from the former by Blue river, which breaks through in a cañon; and the Roan mountains themselves are separated from the Wahsatch mountains only by the entirely similar cañon passage of Green river, which also breaks through the great east and west connecting range known as the Uinta mountains. All of these ranges, some more or less parallel, while others form cross and connecting chains, constitute properly the great mountain formation of the continent, to which the name of Rocky mountains is applied; the former names applying only to the subdivisions of this great feature.]

ANEMONE VIRGINIANA, *Linn.* Prairies beyond Westport, in Kansas Territory.

CLEMATIS PITCHERI, *Torr. and Gray, Fl.* 1, *p.* 10. Prairies between Westport and Cottonwood Creek.

THALICTRUM CORNUTI, *Linn.* Beyond Westport, in Kansas.

RANUNCULUS DIVARICATUS, *Schrank; Gray, Pl. Wright,* 2, *p.* 8. Kansas.

DELPHINIUM AZUREUM, *Michx.* Beyond Westport.

MENISPERMUM CANADENSE, *Linn.* With the preceding.

ARGEMONE MEXICANA, *Linn.* var. ALBIFLORA, *DC.* Walnut Creek.

THELYPODIUM INTEGRIFOLIUM, *Endl. in Walp. Repert.* 1, *p.* 172. Pachypodium integrifolium, *Nutt.; Hook. and Arn. Bot. Beech. pp.* 321 *and* 74. Coochetopa, Sierra San Juan. In flower. "Flowers reddish purple."

THELYPODIUM WRIGHTII, *Gray, Pl. Wright,* 1, *p.* 7 *and* 2, *p.* 12. In the Rocky Mountains. The specimens resemble Wright's No. 845.

CLEOME LUTEA, *Hook. Fl. Bor.-Am.* 1, *p.* 70, *t.* 25. C. aurea, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 122. Sand-banks of Green River, Utah.

PARNASSIA PARVIFLORA, *DC. Prodr.* 1, *p.* 320; *Hook. Fl. Bor.-Am.* 1, *p.* 82, *t.* 27. Rocky Mountains, in the valley of the Grand River; August. This accords with specimens from the northwest coast, and with Hooker's figure (which is not cited in Torr. and Gray, Fl.) but is still more delicate and slender. The filiform scape is five or six inches long; the petals three lines long; the radical leaves less than half an inch long, but abrupt at the base, shorter than their petiole.

SILENE STELLATA, *Ait.* Upper Arkansas.

ARENARIA FENDLERI, *Gray, Pl. Fendl. p.* 13. Rocky Mountains, near the head of the Rio Grande; August. Resembling Fendler's plant, but not so tall.

PARONYCHIA JAMESII, *Torr. and Gray, Fl.* 1, *p.* 170. Plains near Fort Atkinson.

CALLIRRHÖE INVOLUCRATA, *Gray, Pl. Fendl. p.* 16. Prairies near Bluff Creek.

SIDALCEA MALVÆFLORA, *Gray, Pl. Wright.* 1, *p.* 16. Utah Creek; August.

SIDALCEA CANDIDA, *Gray, Pl. Fendl. p.* 24. In the Rocky Mountains, east of the Rio Grande; August. In flower.

SPHÆRALCEA ANGUSTIFOLIA, *Cav.* var. S. STELLATA, *Torr. and Gray, Fl.* Sandy banks of the Arkansas, near the Rocky Mountains.

CEANOTHUS AMERICANUS, *Linn.* Beyond Westport, near the Arkansas River.

POLYGALA ALBA, *Nutt.* Beyond Walnut Creek; July.

PSORALEA OBTUSILOBA, *Torr. and Gray, Fl.* 1, *p.* 300. Kansas; June.

AMORPHA CANESCENS, *Nutt. Gen.* 2, *p.* 92. Between Westport and Bent's Fort.

DALEA LAXIFLORA, *Pursh, Fl.* 2, *p.* 741. Near Walnut Creek; July.

PETALOSTEMON VIOLACEUM, *Michx. Fl.* 2, *p.* 50, t. 37. With the preceding.

PETALOSTEMON CANDIDUM, *Michx. l. c.* With the preceding species.

OXYTROPIS LAMBERTI, *Pursh, Fl.* 2, *p.* 740. Two varieties: one with pale, and the other with violet purple flowers. Rocky Mountains.

ASTRAGALUS ADSURGENS, *Pall.; Hook. Fl. Bor.-Am.* 1, *p.* 149. Rocky Mountains; August.

BAPTISIA LEUCANTHA, *Torr. and Gray, Fl.* 1, *p.* 385. Arkansas River; June.

HOFFMANSEGGIA JAMESII, *Torr. and Gray, Fl.* 1, *p.* 393. Near Fort Atkinson; July.

SCHRANKIA UNCINATA, *Willd.; Torr. and Gray, Fl.* 1, *p.* 400. Upper Arkansas.

RUBUS DELICIOSUS, *Torr. in Am. Lyc. Nat. Hist. N. York,* 2, *p.* 196. Rocky Mountains. Leaves only.

ŒNOTHERA SPECIOSA, *Nutt. in Journ. Acad. Philad.* 2, *p.* 119. Beyond Westport.

ŒNOTHERA SERRULATA, *Nutt.* var. DOUGLASSII, *Torr. and Gray, Fl.* 1, *p.* 502. Beyond Walnut Creek.

STENOSIPHON VIRGATUS, *Spach, Onagr. p.* 64.

GAURA SINUATA, *Nutt.* Near Fort Atkinson.

GAURA COCCINEA, *Nutt. Gen.* 1, *p.* 249. Walnut Creek.

EPILOBIUM ANGUSTIFOLIUM, *Linn.* Common in the Rocky Mountains.

LYTHRUM ALATUM, *Pursh; Torr. and Gray, Fl.* 1, *p.* 481. From Westport to Walnut Creek.

MENTZELIA (BARTONIA) NUDA, *Torr. and Gray, Fl.* 1, *p.* 534. Near Fort Atkinson; July.

CRYPTOTÆNIA CANADENSE, *DC. Prodr.* 4, *p.* 119. Beyond Westport; June.

THASPIUM CORDATUM, *Torr. and Gray, Fl.* 1, *p.* 615. Near Westport; June.

CONIOSELINUM CANADENSIS, *Torr. and Gray, Fl.* 1, *p.* 619. In the Rocky Mountains; August. In flower only.

GALIUM CONCINNUM, *Torr. and Gray, Fl.* 2, *p.* 23. Beyond Westport, Arkansas River; June.

GALIUM BOREALE, *Linn.* In the Rocky Mountains; August.

OLDENLANDIA ANGUSTIFOLIA, *Gray, Pl. Wright.* 2, *p.* 68. Beyond Westport; June.

BRICKELLIA GRANDIFLORA, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 7, *p.* 287. Rocky Mountains; August.

ASTER MULTIFLORUS, *Ait.* Utah Creek; August.

MACHÆRANTHERA TANACETIFOLIA, *Nees; Gray, Pl. Wright, I, p.* 90. Fort Atkinson.

ERIGERON GLABELLUM, *Nutt. Gen.* 2, *p.* 147; *Torr. and Gray, Fl.* 2, *p.* 173. Utah Creek; August.

TOWNSENDIA FENDLERII, *Gray, Pl. Fendl. p.* 70. Valleys in the Rocky Mountains; August.

COREOPSIS PALMATA, *Nutt. Gen.* 2, *p.* 180. Arkansas River.

GAILLARDIA PULCHELLA, *Foug.; Torr. and Gray, Fl.* 2, *p.* 366. Beyond Walnut Creek; July.

ACTINELLA LANATA, *Nutt. Trans. Amer. Phil. Soc.* 7, *p.* 380. White River Mountains, Utah; October. The leaves are nearly smooth, and strongly punctate; awn of the pappus half as long as the scale. Seems about intermediate between this species and *A. Torreyana*, Nutt.

ARTEMISIA FILIFOLIA, *Torr. in Ann. Lyc. N. York*, 2, *p.* 211. Sand-banks of Green River, Utah; October.

ARTEMISIA DISCOLOR, *Dougl.; Besser; DC. Prodr.* 6, *p.* 109. Roubideau's Pass, Rocky Mountains; Sierra Blanca.

ANTENNARIA LUZULOIDES, *Torr. and Gray, Fl.* 2, *p.* 430. Higher parts of the Rocky Mountains; August.

CACALIA TUBEROSA, *Nutt. Gen.* 2, *p.* 138. Beyond Westport; June.

TETRADYMIA INERMIS, *Nutt. in Trans. Amer. Phil. Soc. l. c. p.* 415. Rocky Mountains; August.

LOBELIA LEPTOSTACHYS, *Alph. DC. Prodr.* 7, *p.* 376. Prairie near Westport.

LYSIMACHIA CILIATA, *Ait.* West from Westport, Arkansas River.

ASCLEPIAS PURPURASCENS, *Linn.* With the preceding.

ASCLEPIAS VERTICILLATA, *Linn.; β. Torr. in Nicollet's Report, p.* 154. Fort Atkinson. This is a dwarf variety, being often not more than 3–6 inches high.

ASCLEPIAS TUBEROSA, *Linn.* Beyond Westport, Arkansas River.

APOCYNUM CANNABINUM, *Linn.* Beyond Westport and Walnut Creek; June, July.

EUSTOMA RUSSELIANUM, *Don; Griseb. in DC. Prodr.* 9, *p.* 51. Near Fort Atkinson; July.

GENTIANA AFFINIS, *Grisebach, in Hook. Fl. Bor.-Am.* 2, *p.* 56. In the mountains, near Utah Creek; January.

IPOMŒA LEPTOPHYLLA, *Torr. in Frem. 1st Report, p.* 94, *and in Emory's Rep. p.* 148, *t.* 11. Walnut Creek; July. Dr. James was mistaken in supposing this handsome species to be an annual. It has a large perennial root, which has endured for four or five years in the Botanic Garden at Cambridge.

PHLOX ARISTATA, *Michx.* 1, *p.* 144. West from Westport, Kansas; June.

GILIA PULCHELLA, *Dougl. in Hook. Fl. Bor.-Am.* 2, *p.* 74. Rocky Mountains; August.

POLEMONIUM PULCHERRIMUM, *Hook. Bot. Mag. t.* 2979. Rocky Mountains; August.

GILIA PINNATIFIDA, *Nutt. in Herb. Acad. Philad.*? In the Rocky Mountains, near the head of the Rio Grande; August. If this be a variety of Nuttall's plant (which is Fendler's No. 655) it is remarkable for its much less lobed leaves; those of the branches being mostly entire.

GILIA GUNNISONI, (n. sp.): annual; stem paniculately much branched from the base, nearly glabrous, as are the leaves; the latter alternate and scattered, subulate-filiform, all entire, mucronate; the crowded bracts viscid-puberulent (like the branchlets), subulate, with the dilated lower portion viscidly villous-ciliate, mostly shorter than the flowers, which are capitate-clustered at the summit of the branchlets; teeth of the calyx pungently pointed, a little shorter than the tube of the salver-shaped white corolla; stamens inserted in the sinuses of the corolla, rather shorter than its obovate lobes; ovules 2 or 3 in each cell. Sand-banks of Green River, Utah; October. Root slender, evidently annual; the stems or branches 6 or 8 inches high. Leaves all alternate, slender; the cauline and rameal scattered, filiform; the lower nearly an inch long; the upper gradually reduced to small subulate bracts. Calyx somewhat pubescent. Corolla 3 to 4 lines long, the limb rather shorter than the tube; style pubescent below.

MARTYNIA PROBOSCIDEA, *Glox.* Near Walnut Creek; July.

DIPTERACANTHUS CILIOSUS, *N. ab E. in DC. Prodr.* 11, *p.* 122. Beyond Westport; June.

DIANTHERA PEDUNCULOSA, *Linn.* (Rhytiglossa pedunculosa, *N. ab E.*) Kansas, beyond Westport; June.

PENTSTEMON COBÆA, *Nutt.; Hook. Bot. Mag. t.* 3465. Prairie between Westport and Bluff Creek; June.

PENTSTEMON DIGITALIS, *Nutt.; Hook. Bot. Mag. t.* 2587. With the foregoing.

ORTHOCARPUS LUTEUS, *Nutt. Gen.* 2, *p.* 57. Utah Creek; August.

CASTILLEJA PURPUREA, *Don.* Valleys of the Rocky Mountains; August.

MONARDA FISTULOSA, *Linn.*; *Benth. in DC. Prodr.* 12, *p.* 361. Damp valleys of the Rocky Mountains.

MONARDA ARISTATA, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 5, *p.* 186; *Benth. l. c.* Roubideau's Pass; August. The specimens are evidently annual.

ERITRICHIUM GLOMERATUM, *DC. Prodr.* 10, *p.* 131. Myosotis glomerata, *Nutt. Gen.* 2, *p.* 112; *Hook. Fl. Bor.-Am.* 2, *p.* 80, *t.* 162. Declivities of the Rocky Mountains; August. A very rough form of the plant; flowers white, conspicuous.

SOLANUM TRIFLORUM, *Nutt. Gen.* 1, *p.* 128; *Dunal in DC. Prodr.* 13, *part* 1, *p.* 45. Near the Rocky Mountains; August. Leaves narrower and with fewer teeth on the lobes than usual. Stem branching from the base, and prostrate. Flowers pale blue.

ABRONIA FRAGRANS, *Nutt. in Herb. Hook.; Hook. Kew. Jour. Bot.* 5, *p.* 261. Rocky Mountains; August. This is in Wright's (1711) and several other collections, as well as in Geyer's; but no character of it has yet been published. It is distinguished from A. mellifera by its pure white "porcelain-colored" flowers, scarcely winged fruit, and especially by the involucre, composed of very large, broadly ovate, scarious and white leaflets.

OXYBAPHUS AUGUSTIFOLIUS, *Torr. in Ann. Lyc. New York*, 2, *p.* 237; *Sweet; Choisy in DC. Prodr.* 13, *pars* 1, *p.* 433; var. LINEARIS. Fort Atkinson, Arkansas river, and Roubideau's Pass, Sierra Blanca, Rocky Mountains.

EUPHORBIA MARGINATA, *Pursh, Fl.* 2, *p.* 607. New Fort Massachusetts, San Luis Valley; August.

POLYGONUM LAPATHIFOLIUM, *Linn; var.:* leaves narrowly lanceolate, roughly pubescent on the veins underneath and on the margin; sheaths slightly hairy, ciliate with short hairs; peduncles glandularly pubescent and hispid. Between Westport and the Rocky Mountains; July.

ERIOGONUM ANNUUM, *Nutt. in Amer. Phil. Trans.* (*n. ser.*) 5, *p.* 164; *Benth. Eriog. in Linn. Trans.* 17, *p.* 414. Sandy river valleys, near Fort Atkinson, Arkansas river; July.

ERIOGONUM ALATUM, *Torr. in DC. Prodr.* 15, (*ined.*) *and in Sitgreaves's Rep. p.* 168, *t.* 8. Near the Rocky Mountains, on hill-sides; August. Plant 2-3 feet high. There is some mistake about E. alatum, in *Hook. Jour. Bot. and Kew. Gard. Misc. for September*, 1853. That species is not enumerated in Fremont's reports, and was described for the first time in the report of Captain Sitgreaves, which was not published till the summer of 1853. But specimens of the plant were distributed from Fremont's and other collections, with the manuscript name.

ERIOGONUM JAMESII, *Benth. in DC. Prodr.* 14, (*ined;*) *Torr. in Sitgreaves's Rep. p.* 168. E. sericeum, *Torr. in Ann. Lyc. N. York*, 2, *p.* 241, (*excl. syn.*) On the Sierra San Juan; September. This plant possesses considerable astringency, and is used as a remedy for diarrhœa by the hunters and Indians.

ERIOGONUM CERNUUM, *Nutt. in Jour. Acad. Phil.* (*n. ser.*) 1, *p.* 162; *Torr. in Sitgreaves's Rep. l. c.* This species in its early state has radical leaves only, which are clothed with a white tomentum, and the scape is sparingly branched. Later in the season the lower part of the stem or caudex, below the primary leaves, elongates and repeatedly forks, producing a tuft of leaves at every principal division, thus converting the scape into a leafy stem. Western side of the Sierra San Juan; September. Sepals white, often with a deep rose-colored midrib.

ERIOGONUM EFFUSUM, *Nutt. l. c.* β. LEPTOPHYLLUM, *Torr. in Sitgreaves's Rep. p.* 168, *t.* 10. Declivities of the Rocky Mountains; August.

Var.? FOLIOSUM: branches at first woolly, but at length nearly glabrous, leafy; leaves crowded, linear, revolute when old, nearly glabrous; cymes small, the rays diverging, very short, compound; involucre campanulate, few-flowered, glabrous, acutely 5-toothed; exterior sepals obovate, emarginate, interior similar in form, but one-third smaller. High prairies, San Luis valley; August.

ERIOGONUM LEPTOCLADON (n. sp.): stems slender, moderately branching, the internodes elongated, clothed with a deciduous woolly pubescence, nearly naked above; leaves lanceolate-linear, woolly, like the stem; inflorescence loosely paniculate, the ultimate divisions somewhat racemose; involucre campanulate, woolly, 5-toothed, smaller than the flowers; calyx campanulate; sepals somewhat equal, very obtuse, and slightly emarginate; filaments as long as the sepals, hairy nearly to the summit. Sandy soil on Green river; October. A shrub, about two feet high; the branches dichotomous, or sometimes trichotomous, of a greenish hue when the wool is detached; the ultimate divisions short, and not cymose. Involucre scarcely a line and a half long, few-(6-10-)flowered. Bracteoles linear, minutely glandular on the margin. Perianth glabrous, obtuse at the base. Achenium with a long glabrous beak. Embryo curved, the cotyledons orbicular; radicle enlongated. Allied to *E. effusum*, but much more slender, and differs also in the inflorescence.

ERIOGONUM CORYMBOSUM, *Benth. in DC. Prodr.* 14, (*ined.*) β. DIVARICATUM: shrubby and much branched, clothed with a dense white tomentum; leaves oblong lanceolate, on very short petioles, undulate on the margin, approximated; cymes large and widely spreading, the primary and secondary divisions trichotomous, the ultimate dichotomous; involucre oblong-campanulate, obtusely 5-toothed; flowers (middle-sized) glabrous; exterior sepals broadly obovate, emarginate, the inner narrower and rather shorter; bracteole spatulate-linear; filaments hairy towards the base; ovary attenuated, glabrous; styles very long and exserted. Near springs on Green river; October. About a foot and a half high; leaves about three-fourths of an inch long, and nearly half that breadth. Perhaps a distinct species from *E. corymbosum* of Bentham, which, however, was founded on a specimen in Dr. Torrey's herbarium, collected by Colonel Fremont, very near where Lieutenant Beckwith's plant was found.

ERIOGONUM UMBELLATUM, *Torr. in Annal. Lyc. N. York*, 2, *p.* 241; *and in Sitgreaves's Rep. t.* 12; *not of Benth.* Near the Rocky Mountains.

QUERCUS IMBRICARIA, *Willd. Spec.* 4, *p.* 428; *Michx. f. Sylv.* 1, *p.* 69, *t.* 15. Upper Arkansas. A handsome tree from 35 to 45 feet high, with a trunk sometimes 18 inches in diameter.

QUERCUS ALBA, *Linn.; Michx. f. Sylv.* 1, *p.* 17, *t.* 1. *β?* GUNNISONII: shrubby; leaves oblong, somewhat coriaceous, smooth above, minutely pubescent underneath, pinnatifidly lobed, the lobes nearly equal, entire, semi-ovate, obtuse; fruit on a long peduncle; cup hemispherical; scales oblong, flattish, with a short, abrupt, discolored acumination; gland ovate. On declivities of mountains. Coochetopa Pass, Sierra San Juan. A shrub 6–10 feet high. Acorns less than half as large as in Q. alba.

ABIES TAXIFOLIA, *Lamb. Pin.* 2, *t.* 47. Roubideau's Pass. A handsome tree growing from 35 to 40 feet high, and 12 to 16 inches in diameter. The specimens are without cones. The leaves are from an inch and a quarter to nearly two inches long, very slender and glaucous on both sides.

PINUS (undetermined); apparently between P. flexilis of James and P. Strobus. Highest places in the Coochetopa. Leaves in fives, about an inch and a half long, besmeared with a clear colorless balsam. This is the same pine that Col. Fremont collected on his first expedition, and is noticed in the Botanical Appendix to his Report, 1843, p. 97. For want of the cones, it cannot be satisfactorily determined. Perhaps it belongs to that section of the genus which includes P. edulis, *Engelm.* and P. monophylla, *Torr.*

PINUS SABINIANA, *Dougl. Mssc.; Lamb. Pin.* (*ed.* 2), 2, *p.* 146, *t.* 80; *Endl. Syn. Conif. p.* 159. Valley of the Sacramento. One of the cones brought home by Lieut. Beckwith measured 9 inches in height, by 21 inches in circumference.

JUNIPERUS VIRGINIANA, *Linn.; Michx. f. Syl.* 2, *p.* 354, *t.* 155; *Endl. Synops. Conif. p.* 27. Coochetopa. A small tree, not exceeding 15 feet in height.

JUNIPERUS COMMUNIS, *Linn.; Endl. l. c.* Prostrate under and around trees. Roubideau's Pass.

TRADESCANTIA VIRGINICA, *Linn.; Bot. Mag. t.* 105; *Kunth., Enum.* 4, *p.* 81. Prairies, Upper Arkansas; June.

PLATANTHERA LEUCOPHÆA, *Gray, Bot. N. States, p.* 472. Orchis leucophæa, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 5, *p.* 161. Prairies near Westport.

MELANTHIUM VIRGINICUM, *Linn.; Torr. Fl. N. York*, 2, *p.* 116. Zygadenus Virginicus, *Kunth, Enum.* 4, *p.* 195. Prairies, Upper Arkansas; July.

ZYGADENUS GLAUCUS, *Nutt. in Jour. Acad. Phil.* 7, *p.* 56. Z. chloranthus. *Richards. Append. to Frankl. Narr. p.* 12; *Hook. Fl. Bor.-Am.* 2, *p.* 177. Anticlea glauca, *Kunth, Enum.* 4, *p.* 192. Roubideau's Pass, Sierra Blanca.

SAGITTARIA VARIABILIS, *Engelm. in Gray's Bot. N. States, p.* 461. S. sagittifolia of most American botanists. In water, Upper Arkansas.

HETERANTHERA LIMOSA, *Vahl, Enum.* 2, *p.* 44; *Kunth, Enum.* 4, *p.* 122. Leptanthus ovalis, *Michx. Fl.* 1, *p.* 25, *t.* 5, *f.* 1. Wet places, Westport, &c., Arkansas river. Corolla usually blue, but a white-flowered variety was found with the common form.

CALOCHORTUS VENUSTUS, *Benth. in Hort. Trans.* (*n. s.*) 1, *p.* 412, *t.* 15, *f.* 2, *var?*: sepals erect; petals obovate, bearded and without a spot below the middle, purple at the base. Grows under trees on high mountains. Utah. Stem 2–3-flowered. Leaves grass-like, about two lines wide. Flowers nearly 3 inches in diameter. Sepals lanceolate, striate with purple veins externally. Petals nearly twice as long as the sepals, the upper half white, pale yellowish-green lower down, where the inside is bearded with longish gland-tipped hairs, which are dark purple at the base. Near the base the hairs are more numerous, and form a transverse

tuft; at the very bottom the claw is dark purple. Differs from *C. venustus* in its much narrower and less bearded petals, and in wanting the red spot above the middle.

Allium cernuum, *Roth; Kunth, Enum.* 4, *p.* 435. Roubideau's Pass. Differs from the description of A. cernuum, in the ovary being 6-toothed, or rather with 3 short processes, each of which is 2-lobed.

Carex vulpinoidea, *Michx. Fl.* 2, *p.* 69; *Torr. Fl. N. York* 2, *p.* 376. C. multiflora, *Muhl. in Willd. Spec.* 4, *p.* 233; *Schk. Car. t. Lll. f.* 154. Between Westport and Bent's Fort.

Scirpus lineatus, *Michx. Fl.* 1, *p.* 32; *Torr. Cyp. p.* 332. In thickets, Upper Arkansas.

S. lacustris, *Linn.; Muhl. Gram. p.* 32; *Torr. Cyp. p.* 221. Bluff Creek.

Cyperus filiculmis, *Vahl, Enum.* 2, *p.* 328; *Torr. Cyp. p.* 267. C. mariscoides, *Elliott, Sk.* 1, *p.* 67. Prairies near Fort Atkinson.

Bouteloua curtipendula, *Torr. in Emory's Report, p.* 153. B. racemosa, *Torr. Fl. N. York* 2, *p.* 449; *not of Lag.* Chloris curtipendula, *Michx. Fl.* 1, *p.* 59. Atheropogon apludoides, *Muhl. Gram. p.* 287. Prairies, Upper Arkansas.

Chondrosium oligostachyum, *Torr. in Marcy's Report, p.* 300. Atheropogon oligostachyum, *Nutt. Gen.* 1, *p.* 78. Eutriana? oligostachya, *Kunth, Enum.* 1, *p.* 96, *and* 2, *p.* 282. On the Upper Arkansas.

Sesleria dactyloides, *Nutt. Gen.* 1, *p.* 65; *Kunth, Enum.* 1, *p.* 323; *Torr. in Emory's Report, p.* 323, *t.* 10. With the last. The flowers are all male in the specimens of this collection. There are thrown out from the root, besides the upright flowering culms, long prostrate runners which produce short verticillate branches and tufts of leaves at the joints, where they also frequently strike root.

Andropogon Torreyanum, *Steud. Syn. Gram. p.* 302.

A. Jamesii, *Torr. in Marcy's Report, p.* 302. A. glaucum, *Torr. in Ann. Lyc. N. York* 1, *p.* 153; *not of Muhl.* Sources of the Arkansas.

Spartina cynosuroides, *Willd. Enum.* 1, *p.* 80; *Torr. Fl. N. York* 2, *p.* 448, *t.* 153. Lowlands of the headwaters of the Arkansas.

Tripsacum dactyloides, *Linn.; Kunth, Enum.* 1, *p.* 469; *Steud. Gram. p.* 362. Plains of the Arkansas.

Elymus Canadensis, *Linn.; Kunth, Enum.* 1. 451; *Torr. l. c.* 476. Between Westport and Bent's Fort.

Panicum capillare, *Linn.; Kunth, Enum.* 1, *p.* 114; *Torr. l. c. p.* 426. With the preceding.

Panicum Crus-galli, *Linn.; Torr. Fl. N. York,* 2, *p.* 424. Damp places. Upper Arkansas. The flowers are hispid and mostly awnless.

EXPLANATION OF THE PLATES.

Plate I. Viola Beckwithii.

Fig. 1, the petals; 2, vertical section of a flower; 3, 4, 5, stamens; 6, pistil; 7, capsule and calyx. All magnified.

Plate II. Sidalcea candida.

Fig. 1, vertical section of the column, ovary, &c.; 2, upper part of the staminеal column, entire; 3, fruit, of the natural size; 4, fruit and calyx; 5, a mature carpel; 6, a seed. All but 3 magnified.

Plate III. Astrgalus Beckwithii.

Fig. 1, vexillum; 2, a wing; 3, keel; 4, calyx and pistil; 4, stamens; 6, pistil, the ovary vertically divided. All enlarged.

Plate IV. Œnothera tanacetifolia.

Fig. 1, vertical section of a flower; 2, stamens; 3, pollen; 4, ovules. All variously enlarged.

Plate V. Tetradymia glabrata.

Fig. 1, a capitulum; 2, receptacle; 3, a flower; 4, corolla and stamens; 5, corolla and stamens laid open; 6, a stamen; 7, transverse section of the ovary; 8, pistil, with the ovary vertically divided; 9, stigmas; 10, a bristle of the pappus. The details variously enlarged.

Plate VI. Pentstemon heterandum.

Fig. 1, a flower; 2, diagram of the æstivation, &c.; 3. 4, normal form for the genus of æstivation of the corolla; 5, vertical section of a flower; 6, corolla laid open, with normal stamens; 7, 8, anterior and posterior view of a perfect stamen; 9, 10, 11, the fifth stamen more or less antheriferous; 12, the fifth stamen reduced to the usual sterile filament; 13, pistil. The details variously enlarged.

Plate VII. Phacelia humilis.

Fig. 1, a flower; 2, corolla laid open, with the stamens; 3, 4, stamens; 5, pistil and calyx; 6, the same in fruit; 7, capsule, &c., vertically divided; 8, a seed; 9, vertical section of the same. The details more or less magnified.

Plate VIII. Phlox canescens.

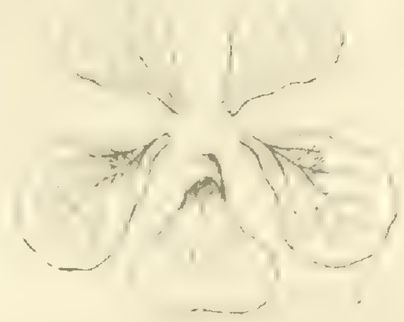
Fig. 1, a flower; 2, the same laid open; 3, 4, stamens; 5, pistil; 6, ovary horizontally divided; 7, vertical section of the ovary. The details variously enlarged.

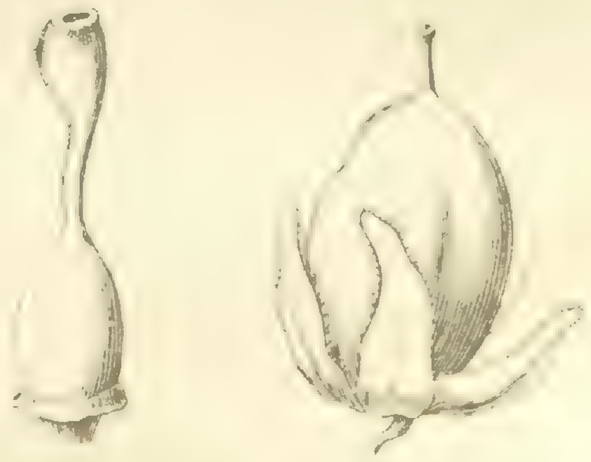
Plate IX. Gilia Gunnisoni.

Fig. 1, a flower; 2, calyx laid open; 3, corolla laid open; 4, pistil—pistil with the ovary vertically divided; 6, ovary transversely divided; 7, calyx and capsule. Details variously enlarged.

Plate X. Abronia fragans.

Fig. 1, a flower; 2, the same laid open; 3, anther; 4, stigma; 5, immature fruit.





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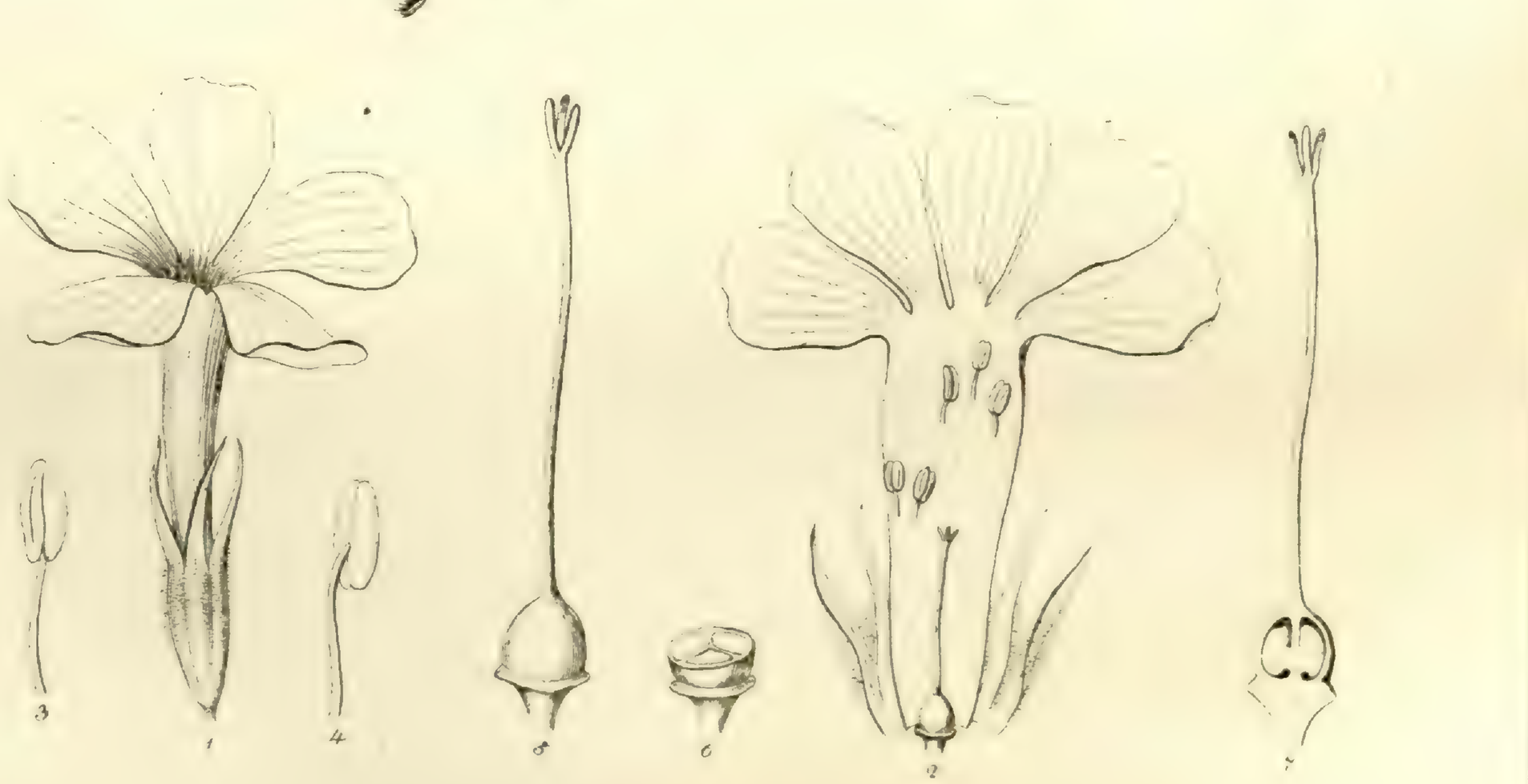
Ackerman Lee & Freudenrich

ASTRAGALUS BECKWITHII.

ŒNOTHERA TANACETIFOLIA.

TETRANEURIS GLABRICA



Sherman Lith. 579 Broadway N.Y.

PHLOX CANESCENS.

PHACELIA HUMILIS

Ackerman Lith. [illegible] N.Y.

PENTSTEMON HETEROPHYLLUM

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Ackerman Lith. 379 Broadway N.Y.

ABRONIA FRAGRANS.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.
WAR DEPARTMENT.

SYNOPSIS OF A REPORT

OF THE

RECONNAISSANCE OF A RAILROAD ROUTE

FROM PUGET SOUND

VIA

SOUTH PASS TO THE MISSISSIPPI RIVER:

BY

FRED. W. LANDER,
CIVIL ENGINEER.

WASHINGTON, D. C.
1856.

CONTENTS.

	Page.
Legislative and executive action in reference to exploration and report	5
INTRODUCTION	7
Review of Pacific railroad project	8
Different systems of railroad construction	11
Routes	16
Construction of a first section, the preliminary and most efficient step towards the early consummation of the undertaking of a railroad to the Pacific	17
The credit system of construction	19
How a cash system of construction might be applied	21
Conclusion of Introduction	23
Circumstances under which the reconnaissance was conducted	25
REPORT	29
Blue Mountain range	31
Selection of a terminus on Puget Sound—first section of line	31
Section of route from Vancouver to Dalles of Columbia	32
From the Dalles to Fort Boisé	32
Connexion of branch route with central lines to California	34
Estimates of cost	34
Continuance of reconnaissance to Missouri river	36
Review and comparison of northern and southern routes to Puget Sound	39
Remarks	43
Conclusion	44

LEGISLATIVE AND EXECUTIVE ACTION

IN REFERENCE TO

THIS EXPLORATION AND REPORT.

RESOLUTIONS OF THE LEGISLATIVE ASSEMBLY OF WASHINGTON TERRITORY.

Whereas Frederick W. Lander, esq., civil engineer, of acknowledged reputation and high standing in his profession, has undertaken the examination of a railroad route from Puget Sound, by the valley of the Columbia, to the vicinity of the South or Bridger's Pass of the Rocky mountains, to connect with a railroad to California; and whereas this examination is conducted at the present time, that reliable information regarding the line in question may reach Congress during the present session, and prior to any final action upon the Pacific railroad routes; and whereas it is the opinion of this legislature that the result of this exploration will possess such a reliable scientific and practical character as to entitle it to equal consideration by Congress with those more officially conducted:

Resolved, That, in view of the importance of this exploration, its scientific character, and the value of its results, our delegate in Congress be, and hereby is, instructed to present the report of this examination to the Congress of the United States, and to use his best endeavors to procure its publication as a public document.

And be it further resolved, That our delegate in Congress is instructed to use his efforts to procure such an appropriation as will compensate Mr. Lander for this arduous and perilous service, and repay the necessary expenses incurred by this survey.

Passed both Houses unanimously, March 7, 1854.

Attest:

ELWOOD EVANS, *C. Clerk C.*
B. F. KENDALL, *C. Clerk H.*

Resolved by the Legislature of the Territory of Washington, That F. W. Lander, esq., civil engineer, in undertaking the arduous and perilous enterprise, at his own expense, of an exploration and survey of a railroad route, by the valley of the Columbia, through the Rocky mountains—a matter of the highest importance to the interests of this Territory—is entitled to the gratitude of this legislature, and we hereby tender him our thanks and best wishes for the success of his undertaking.

Passed both Houses unanimously, March 7, 1854.

Attest:

ELWOOD EVANS, *C. Clerk Council.*
B. F. KENDALL, *C. Clerk House.*

RESOLUTIONS OF THE HOUSE OF REPRESENTATIVES, INTRODUCED BY HON. JAMES A. McDOUGAL, OF CALIFORNIA.

CONGRESS OF THE UNITED STATES,
In the House of Representatives, August 3, 1854.

On motion of Mr. McDOUGAL,

Resolved, That the Secretary of War be requested to procure a report from Mr. F. W. Lander, civil engineer, of a survey of a railroad route from Puget Sound, by Fort Hall and the

Great Salt Lake, to the Mississippi river, and that he cause a copy thereof to be furnished to this House.

Resolved further, That the reports of surveys for a railroad to the Pacific, made under direction of the Secretary of War, also the said report of F. W. Lander, be printed for the use of the House during the recess.

Attest: JNO. W. FORNEY, *Clerk H. R. U. S.*

LETTER OF SECRETARY OF WAR.

WAR DEPARTMENT,
Washington, August 8, 1854.

SIR: In compliance with a resolution of the House of Representatives of the 3d instant, "That the Secretary of War be requested to procure a report from Mr. F. W. Lander, civil engineer, of a survey of a railroad route from Puget Sound, by Fort Hall and the Great Salt Lake, to the Mississippi river, and that he cause a copy thereof to be furnished to this House," I apply to you for the report mentioned therein.

It is proper that I should inform you that there is no fund at my disposal that will enable me to make any remuneration for the document, or for any expense attending the furnishing of it.

Very respectfully, your obedient servant,
JEFF. DAVIS,
Secretary of War.

F. W. LANDER, Esq., *Washington.*

LETTER TRANSMITTED WITH REPORT.

WASHINGTON, *November* 23, 1854.

SIR: Your letter of August 8th, containing a copy of a resolution of the House of Representatives, and applying to me for a report therein mentioned, was duly answered.

I have the honor to submit herewith a report of the result of my late examinations of a railroad route from Puget Sound, via the South Pass, to the Mississippi river, accompanied by introductory remarks deemed necessary for its explanation.

A series of meteorological observations conducted during the reconnaissance are at the service of the Department.

I am, very respectfully, your obedient servant,
F. W. LANDER.

HON. JEFF. DAVIS,
Secretary of War.

RESOLUTION OF HOUSE OF REPRESENTATIVES, FEBRUARY 14, 1855.

Resolved, That there be printed, for the use of the House, ten thousand copies of the reports of surveys for a railroad to the Pacific, made under the direction of the Secretary of War, embracing the report of F. W. Lander, civil engineer, of a survey of a railroad route from Puget Sound, by Fort Hall and the Great Salt Lake, to the Mississippi river; and the report of J. C. Fremont, of a route for a railroad from the head-waters of the Arkansas river into the State of California, together with the maps and plates accompanying each of said reports, necessary to illustrate them.

Attest: JNO. W. FORNEY, *Clerk H. R. U. S*

INTRODUCTION.

EXPLORATIONS of the wild interior, for the purpose of ascertaining the most economical and practicable route for a railroad to the Pacific, are reconnaissances* rather than surveys. They are engineering studies of *routes*, or belts of country, often of two hundred miles in breadth, of two thousand miles in length, extending from the verge of the eastern border to the Pacific, of which the characteristics are to be known regarding railroad construction.

Routes are not lines; several lines might occupy relative positions on a single route.

The lineal section, rapidly placed by the labors of a single season, and presented as the result of a Pacific railroad exploration, must not always be presumed to be a profile of the preferable or the very best trace for location, existing upon the division examined. From the limited time prescribed for making these examinations, and from the vast extent of country explored, the first line of barometric levels does not always occupy the best position of the route to which applied.

The engineering features of the whole broad division passed over are connected with this base line, and stated in the form of opinions or convictions forced upon the mind of the engineer by former experience of the necessities of location in all varieties of country.

The study of reconnaissance is not, however, confined to single divisions. In its broadest application, it compares routes rather than lines; states their relative merits, and, by a simplified system of hurried field service, restricts the costly and tedious labors of elaborate instrumental survey to the preferable division; and, even upon that division, to a limited section of surface.

Thus, distinct knowledge of extreme, or nearly impracticable obstacles, upon routes involving deep national interests, the existence of which may lead to the abandonment or neglect of important termini, or to the repeated and expensive application of instrumental survey to solve what nature made insurmountable, directs the attention of reconnaissance beyond the narrow limits of sectional location.

And as reconnaissance directs reconnaissance; as the labors of survey are pursued as its results, and are involved and tedious in their deferred conclusions, the developments of the first important service cannot be too speedily continued to their limit when tending to prevent more costly expenditure by anticipating proposed surveys by additional information, which changes their direction.†

In all reconnaissances of location for the selection of the route or the line of a route of a railroad, some requisition to be answered must be present in the mind of the engineer. The interrogation, For what am I here seeking? should be evident to his senses and aid his study.

There are different classes of railroads; different plans of construction.

* *Railroad reconnaissance.*—To look, to view; the study of country with limited use of instruments, to procure information of its characteristics regarding railroad construction.

Report of reconnaissance.—To describe and submit conclusions from inferences drawn.

Railroad survey.—Instrumental examinations, by which surfaces are measured.

Report of survey.—To state by accurate deductions from data gained.

† I shall again refer to this brief definition in giving the reasons why the exploration, of which this report is the result, was conducted at an unfavorable season of the year, by private means, and was endorsed by unanimous resolutions of the legislative assembly of Washington Territory.

In the selection of the route of a railroad to the Pacific, the requisition as to the class of line to be adopted, and the plan of construction to be attempted, is the first and salient feature of the whole question.

This unsolved problem in engineering is dissimilar from that of any road hitherto completed. It is, nevertheless, a problem to which one system of construction is more particularly applicable than any other; the physical obstacles to be overcome are in no degree to be deemed subjects of consideration, as compared with the practical difficulties which conspire to prevent its ready solution.

The opinions of professional parties on this question, which are the result of experience in railroad-building, should meet the direct notice of legislation.

If it can be readily demonstrated that the selection of the class of line which will best solve the present urgent necessities of this nation for rapid and effective means of overland communication restricts the whole question to the selection of a route or routes over which such a class of line or mode of building can alone be attempted, then the choice of these routes should not be made subordinate to any other consideration.

It is not yet particularly known that a wagon-road, a rough, rapidly extended railroad, suited to military and mail transportation, and an elaborately completed, thoroughly equipped Grand Trunk railroad, can each exist in their turn, as called for by the necessities of civilization, and each aid as successive steps towards the consummation of the legitimate object required.

The wagon-road and the rough railroad come within the limits of discussion of constitutional legislation; and if deemed expedient, would progress together. But the Grand Trunk road, if viewed only in legislation as the development of a requisition beyond the reach of constitutional aid, would alone appear as the result of the efforts of private parties to procure remuneration to a patriotic and commendable enterprise by the carrying trade of western commerce.

A review of this whole question is necessary to the purposes of the present report, and as an explanation of the engineering views herewith submitted.

REVIEW OF THE PACIFIC RAILROAD PROJECT.

It is now nearly ten years since the patriotic Whitney first advocated the construction of a railroad to the Pacific. He then asserted that, in working out the grand problem of self-government, this nation occupied a position to command the influx of that commerce of the Indies, which had caused the prosperity of nations to ebb and flow like the waters of the sea over which it had been transported. He visited the principal cities of the Union. He addressed the legislatures of States and the Houses of Congress. He spoke of the development of territory; of the march of a martial people towards the shores of the distant Pacific; of a great highway of nations existing through a line of flourishing settlements; of commerce and agriculture walking hand in hand; of the east and of the west united. He enforced these arguments with the full powers of a commanding intellect, and by the expenditure of his private fortune. But he failed of receiving the support of congressional legislation; and as long lines of railway had never successfully competed with water transportation, private individuals declined this investment without government aid. Whitney went to England. He was received and noticed with honor. He addressed the British Parliament; but he was never able to achieve this grand purpose and glory of his existence. His patriotism and the devotion of his high nature only have their record in the present character of this great project, now fully before the American people, and with which his name must forever remain connected.

But the idea of a Grand Trunk railroad, elaborated from the very outset to the needs of an immense carrying trade, built in sections of one hundred miles, by a system of land grants, and existing, by some act of intuition on the part of its well-wishers, over mountain ranges, mighty rivers, sterile deserts, and regions devoid of wood, building materials, and sources of supply, has never yet been surrendered. When the munificent land grants of Texas, held out as a

bonus to capitalists, led to the creation of a mammoth company, and influenced the voice of the press, this idea of a Grand Trunk road was strenuously urged by eloquent advocates. It appeared in the glorious arguments of Benton. It still lies like an incubus on every effort made by professional parties to divest this national project of those objectionable features which have so long placed it in the light of a chimera and an experiment.

While the whole question has changed in its character, and that feature* which for nearly ten years barely elicited public notice, and failed of gaining the attention of congressional legislation, is no longer the leading, but has become the subordinate requisition of the problem, it is still allowed to weigh upon and embarrass the action of government.

The claim of the Pacific coast to better means of overland communication, unexpectedly made prominent by the discovery of the gold-fields of California, and the corresponding development of the Territories of Utah, Oregon, and Washington, was at once thought a necessity of such character that its solution could not be waived or postponed without vital injury to the best interests of the nation and to those important and isolated communities.

For this reason, in the very first discussion of this new and striking feature of the question, many patriotic individuals proposed the extension of a wagon-road. Others, in ignorance of the various classes of railwàys, advocated the immediate adoption of the grand plan of Whitney. It was urged by the latter that the great plains of the interior were already whitened by the bones of American emigration in the passage of a wagon-road.

The railroad of the isthmus of Panama, extending through an unhealthy climate and over foreign soil, had been projected and carried to its completion by the impulse of American energy. With the aid of government, this project might readily be completed by the enterprise of private individuals over our own territory, and by a route avoiding the fatal fevers of the south. Mails, troops, and munitions of war could be safely and rapidly transported; and the great travelling population of the east and west no longer be exposed to the dangers and inconveniences of the isthmus transit.

But grave questions now came up for consideration. It was open for argument, how far Congress might aid the speculative operations of private parties, save as the most direct step towards the legitimate consummation of a single object in view.

The united sovereignties which jointly possessed the broad domain extending from the east to the Pacific would necessarily act with caution in entering the debatable ground of constitutional rights.

The nation was then laboring under the results of a disastrous depression and derangement of the business relations of the country. This state of things had been produced by an unhealthy mania in railroad speculation, not only unrestricted, but in a measure urged forward by the indiscriminate patronage of local legislation.

The unwieldy operations of companies under the management of interested private parties had not always been guided by the true spirit of patriotism. No argument of mere expediency should affect the action of government. In treating this question, Congress, acting under constitutional limitations, could only continue to insure a perfect union, domestic tranquillity, and common defence; further the general welfare; regulate the land forces; provide for calling forth the militia to repel invasion; promote the progress of science and art; defend California against invasion, and perhaps, by the extension of a post-road, give to her citizens the privileges enjoyed by other sovereign States.

No preference could be given, even by the establishment of a regulation of commerce, to one State over another; and it would require a power of discrimination very difficult of application to decide to which portion of the Union should accrue these supposed wonderful advantages, in the development of a project claiming the aid of a government strictly bound to render exact and equal justice to all.

* The idea of procuring the influx of western commerce to the United States of North America by building a Grand Trunk railroad across the continent.

It is well known that these questions were left to the consideration of Congress. The representatives of a people known to possess more mechanical ingenuity and constructive faculty than any nation of the globe, were called upon by the united voice of the nation to look this subject of overland communication boldly in the face; to view it in its manifold relations; to grapple with its great apparent difficulties; and, if constitutional, to decide *when, where, and in what manner*, it could be best and most speedily accomplished. All sources of information were open to them; and, if a problem and an experiment, it could be met by the full force of that acute American intellect which had done, and will continue to do, so much towards accomplishing the destiny of this wonderful republic.

If it was denied that government had constitutional power to act in the premises, it certainly did not require argument to prove that those distant communities, the unparalleled development of which had been the growth of an epoch in the history of human progress, were an integral portion and a part of the republic; and it was also evident that they were entirely isolated and unprotected. *By the constitution, Congress was compelled to defend California against aggression.* It was well known, in these years of revolutions and of counter-revolutions, that the United States of North America had become an object of suspicion and of dread to older and less progressive nations.

In the event of war with one or more of the great powers of Europe, California could not be defended against aggression by the means then within the command of the general government. Troops, supplies, and munitions of war would be exposed to the dangers and costs of the inadequate modes of transit, of a broken and interrupted water transportation, and to the passage of an unhealthy, and, in that event, probably a hostile foreign territory.

It had ever been the policy of this government to restrict the military operations of the country to a simple and effective character. Her volunteer soldiery had already made the wars of America immortal. Rallying the energetic population of every hill-side and prairie around that gallant and efficient military organization, which would compare in ability and attainment with that of any service of the earth, it was evident that the necessity of the occasion would require the rapid transportation of these suddenly-collected forces to the utmost verge of her remotest border.

In view of the achievements of science and the mechanic arts, and the advanced stage of human progress in the nineteenth century, a military road could no longer be deemed the means of crossing a river or making passage of a hill-side. In reference to the exigencies involved, it was the application of that mode of transit which had in a measure annihilated distance, to a route of two thousand miles in length, from the populous eastern States to California.

It was the definite solution of the requisition of a new, unexpected, and striking necessity, by the use of the best means at the command of the nation.

The demand was immediate. If it was within the power of government to act in the premises at all, then *when* government should act on the question became evident to the weakest observer.

If it was within the power of government to act in the premises at all, then *where* government should carry this project to early consummation grew out of the national requisition of military defence, and those claims which had led to the attention of Congress.

If it was within the power of government to act in the premises at all, then *in what manner* it could be best and most speedily accomplished would be devised by the wisdom of legislation, in order to avoid those misfortunes which, in the development of minor and local railroad projects, had affected the business relations of the country, and had been noticed by a message of the President.

But the project was yet to be placed in a position to become the object of a fostering legislation; an undertaking which, to aid would be national, and to achieve, patriotic.

Unprofessional parties had invariably confounded the domestic and commercial relations of the problem with that distinct and salient constitutional feature which gave Congress power to

act upon it. The question as to whether government could use the iron rail and locomotive engine in the extension of a post-road over two thousand miles of uncivilized country, and that mode of transit which had in a measure annihilated distance, as a means of defending a distant sovereign State against aggression; permitting a proper regulation of the land forces, by rapidly transporting the suddenly-organized forces of her volunteer soldiery to the distant unprotected portions of her domain; whether or not a military road should still be considered that sort of structure which existed at the date of the constitution, or be superseded by the triumph of human ingenuity;—this question had been merged by legislation in an endeavor to answer the anticipations of private individuals, who sought to change a government of general and limited powers into a party speculating with the lands and funds of the people, by aiding an experimental endeavor to procure the influx of western commerce to some single State or section of the Union, perhaps to the detriment of all the rest. This brings the subject to a connexion with my report.

If, from want of professional information, the treatment of this subject has hitherto been reversed in its nature, and the need of the hardy pioneer of civilization has been merged in the claims of the capitalists of the eastern cities, it may readily be placed in a clearer point of view.

A few simple engineering statements will enable the wisdom of Congress to determine how far the power of the constitution will permit government to aid in the furtherance of the operation of private parties towards attaining results desired, and where the restrictions of legislation might be interposed.

I shall endeavor to establish the plain engineering position, that government may act in the premises without risk to first outlay; and if it shall seem expedient to extend a means of communication over our soil to the Pacific possessions, that the use of that mode of transit, perfected by human ingenuity, need not be surrendered on constitutional grounds. I shall also not hesitate to state, most emphatically, that the subordinate or latent feature which has so long given a Pacific railroad project character in the estimation of private parties, and which is not so well entitled to the notice of legislation, is in no degree harassed or restricted, but is in a measure urged forward to earlier consummation by the proper treatment of this undertaking as an engineering problem.

DIFFERENT SYSTEMS OF RAILWAY CONSTRUCTION.

The plan of building a Pacific railroad, which has been so long presented, by extending it in sections of one hundred miles, elaborated from the outset to the full needs of the immense carrying trade of western commerce, and slowly verging towards the wild interior, is that of the English system of construction.* Built on such a plan, by the use of credits, bonds, and mortgages, and by a brokerage over a basis of land grants, it would combine all the disadvantages of both the American and English modes of construction. These are very dissimilar. The English system, adopted in building the first roads of New England, has been modified in America to more expeditious and less costly methods of attaining the results required.

Although the Pacific problem is different from that of any road hitherto completed in civilized regions, it is nevertheless one to which the present American modes of building, *divested of their objectionable features*, are more particularly applicable than any other. It is that of the

* *Grand Trunk, or first-class railroad, English.*—A (practicably) direct route between termini reduced to a close approximation to level gradients, without attempts at deflection to reduce cost. A line of durable and costly works, drained, sodded, and elaborately prepared in road-bed and permanent way for the rapid passage of weighty trains; thoroughly equipped and furnished, of gauge adapted to traffic and connexions.

Grand Trunk, or first-class railroad, American.—A line adjusted to irregularities of surface, between termini, by application of curvature and gradients, regarding obstacles to be overcome and traffic to ensue. A road-bed ditched, sloped, and drained, and made ready for the rail by a cheap ballasting of clear gravel. A superstructure adapted to the passage of weighty trains at paying rates of speed. Works erected in apprehension of a division of traffic with competing lines, as avoiding misdirection of capital and the entailment of high rates of fare. In view of improvements in transportation liable to ensue, and contingencies which inevitably occur, omitting as extravagant and unnecessary many of the operations deemed indispensable to foreign first-class construction.

extension of a road over an uncivilized, and in many instances uninhabitable, country; and the American system is that of the rapid extension of lines, at low cost, over undeveloped and non-paying routes of transit.

The Pacific railroad is to reach a terminus two thousand miles distant, from which a revenue is anticipated; but until this anticipation of revenue is answered, must be restricted, in development, to the simple requirements of military and way transportation.

The American system of building is one by which a line may pass through various stages of elaboration to any class or character required, *even after the connexion of termini has been accomplished;* for it is the great principle of the American "open construction account," that a road should not be placed under the serious liability of maximum equipment for service it may never be called upon to perform; but, if practicable, should be made to reach and develop the sources of future traffic, under the support of a way transportation at paying rates. From the operations of interested and unscrupulous speculators, often occupying the position of railroad directors, and gambling with the funds of stockholders committed to their charge, and *especially in the building of short lines where permanent construction should have been deemed expedient from the outset*, the system of the open construction account has encountered great opposition, and has been unwarrantably assailed by unprofessional parties.

Under the present credit system, (one of the evils of the American mode of building,) from the necessities of brokerage, and premiums, and the gambling liabilities, borne by innocent stockholders, a mere percentage of the amount of margin presented as the cost of roads is devoted by the American constructing-engineer to their actual working. This has been one of the chief reasons why the cost of American roads has so often exceeded their engineering estimates.

Over twenty-five per cent. of the amount now invested in lines of the United States has proved a total loss to the original stockholders. The civil engineers of the country have very generally borne the odium of these liabilities; which is probably the reason why their opinions have such slight weight when brought to the consideration of this national undertaking.*

Yet this project is one to which the application of the American system of expansion will restrict the first liabilities of wear and tear, depreciation and deterioration, risk or loss of outlay, and all questionable expenditures, to the minimum, in the construction of a line which, from the length of route traversed, before connexion can occur with a paying terminus, will not warrant first-class construction and equipment from the outset. It would require a period of twenty years to build such a grand road to the Pacific, on the obsolete system proposed. During this space of time those portions of the road first completed would thrice need renewal as worn out

* We are too apt to confound the achievements of science and art by the first nations of Europe, with the only available methods of accomplishing similar ends in our own country. The great mass of the American people are also too ready to believe that it is from want of some natural gift or cultivation of peculiar qualities that our own countrymen do not erect works bearing favorable comparison with those of older nations.

A few years ago the public press was teeming with accounts of the projection of a Grand Trunk railroad in Canada. A noted English engineer had arrived. A company of English capitalists had been formed. A bridge was to be built across the great valley of the St. Lawrence, rivaling any structure of modern Europe. Some comparisons were made and reflections cast, regarding European and American railways, not wholly complimentary to our own mechanics and engineers. But within a short period it has been made public that the stock of this famous company has become a drug upon the market, and that the business of the grand road affords so slight prospect of paying the interest upon the capital invested, that there is great danger of the total abandonment of the enterprise. Thus the system which had been found to succeed so admirably in the densely populated counties of Great Britain, became totally inapplicable to the needs of a less remunerative route of transit.

I particularly refer to this case, because this Grand Trunk road was extended as the first step towards a Pacific railroad, and because its failure is an example of what may be apprehended by a like incomprehensive treatment of our own Pacific project.

Extract from a speech of Hon. James A. McDougal, delivered in the House of Representatives on the 29th of May, 1854.

"The line from Halifax, through the British possessions, to the Pacific, is a project contemplated by our northern neighbors, and in it they have the support of heavy English capital."

and decayed. The amount of the cost of this renewal would absolutely construct and equip a road of medium class, with ordinary management reaching the Pacific in ten years, and, if necessary, even in five years. This preliminary road would not make a passage of the same obstacles by reduction of surface, nor adopt so direct a line as a Grand Trunk road; but select a route giving the most rapid results to first outlay, by at once answering the present needs of the nation. It would also accomplish that first step towards the construction of a grand road, which would eventually insure its completion without great loss to its projectors, or, more properly, to the government finding means for extending it.

A doubt exists in the minds of practical individuals whether the traffic of a Grand Trunk overland railroad will ever support its running expenses. Hence, there is an experiment to be tried.

Government is not particularly interested in the question as to whether the commerce of the Pacific seas will pass over this line, when built, or continue to be borne by clipper-ships around the southern extremity of South America. Government is interested in the solution of the problem only so far as the results of the experiment tend towards the extension of a speedily consummated effectual means of overland mail and military transportation.

But while government will hesitate to exercise doubtful constitutional powers, and will practise due economy in the expenditure of the money of the people, it will, when not conflicting with those powers, seek to further all important domestic and commercial relations.

While the idea of a Grand Trunk road must be treated with caution, because, so far as government has constitutional powers to act on the question, the choice merely lies between the use of the iron rail and of the wagon-road, and it can be demonstrated that the use of the iron rail can take place prior to the completion of a grand road; yet, as regards the choice between the use of the iron rail and of the wagon-road, the probability of the future construction of a Grand Trunk Pacific road should be brought into the discussion.

The experiment as to whether the commerce of the west will pass over the American continent by rail-way, even when a rail-way is in operation, cannot be tried by the extension of a wagon-road. But it can be practically tested by the extension of a railroad only suited to the absolute needs of military and way transportation.

Again, should this experiment prove successful, then the Grand Trunk railroad of the present day would be wholly inadequate to the amount of transportation required. The broad uncultivable wastes of the American continent (over any route whatever) are unlike the present railroad routes of civilized regions. They compare with them as the drear expanse of the ocean contrasts with the inland navigable waters of our lakes and rivers. When this sea of space is to be traversed with the certainty of a paying business, with no important way stations, and an enormous through traffic to warrant the running of trains, the locomotive engine will make passage of the level sand wastes of the wild interior at rates of speed which will startle human credulity. And when the same inventive genius which once so readily modified the costly modes of building of older nations to the means and demands of our own new and undeveloped country, is called upon to grasp the broader conclusion, and solve this future necessity of civilization and of progress, then the Pacific railroad will resemble the present Grand Trunk road of populated countries as the new British steam-ship Great Eastern compares with the first-class steamer of the coast. Thus, while the first study of this question should be grounded on a comprehensive desire to answer *at once*, and in the best manner, that which is at present required; yet, in view of the grand prospective contingencies presented, it should also be definitely guided by a full apprehension of that which is liable to occur. The conclusion is, that if government should see fit to construct a railroad, necessarily in connexion with, but in preference to, the extension of a wagon-road, then a railroad suited to military transportation, and to the mere testing of this experiment, is the class of road to be attempted. In this connexion, the assertion of the unprofessional observer, "that it is always cheapest in the end to build a good road first," must have no weight. A road suited to the needs of way and military

transportation is necessarily *a good road*, and, built by the aid of government, should not be accepted if of unstable or insufficient character. It is the choice of route, and nature of surface passed over, which reduces its cost and favors its rapid extension, and which is, in reality, the chief argument for its use in preference to the wagon-road.

But I will close this argument by asserting that no road of permanent works and substantial class *can be built* across the continent with only the use of a wagon-road as a vehicle of transportation. The appliances of civilization, and the materials of construction, must be placed contiguous to the works by progression of settlements, or by the prior extension of a pioneer or preliminary railroad. But although permanent works may be erected by awaiting the tardy progression of settlements through the fertile border country, they cannot thus be raised in the far interior. Long sections of all routes are there devoid of wood, stone, and every variety of building materials. Broad divisions are not susceptible of development by settlements, and can never become provision-producing districts. From the distance to be passed over, and the amount and speed of transportation required, labor can neither be supplied nor supported.

Weighty materials cannot be moved over the hundreds of miles from where, existing in natural deposits, they must be furnished to sections deficient. Mules, oxen, and horses fail, break down, and die by scores, in making passage of those distant, sterile, and arid plains. The use of the iron rail and locomotive engine is that means of transit perfected by human ingenuity to the best practicable result for the moving of weighty materials at high rates of speed and at low cost. In fact, it cannot be denied that it fully transcends all other modes of land locomotion.

These very routes, where domestic animals can hardly be made of use, and where the supplies of human subsistence cannot be procured, can be readily developed by railway, by laying a rough superstructure on the natural surface of the earth, and thus the very best means of transportation can be supplied.

The whole pecuniary question regarding the treatment of this project of a railroad to the Pacific resolves itself into the expenditure of the least amount of cash capital without reasonable prospect of remunerative return. The engineering question resolves itself into the obtaining of some rapid and effective means of transportation along the route of the grand road, *that it may be constructed at all.* The first relation is, the distance to be passed over before connexion can occur with a paying terminus; and the second, the stupendous nature of the nearly insurmountable obstacles and practical difficulties which will serve to postpone the completion of any road of first-class character. Both presentations of the subject are wholly subordinate to the great and immediate need of the Pacific coast, to the healthy overland military and mail transportation, which is the single constitutional requirement in the premises. This is a requisition which cannot be waived or postponed. A wagon-road will not answer it, and a permanent railroad cannot be legislated towards the Pacific by the will of its well-wishers, under incomprehensive views of the difficulties attending its extension.

Therefore, with a full sense of the importance of such an opinion, and a definite knowledge of at least two of the great routes across the American continent, I propose the extension of a rough American railway, of weighty superstructure, but of medium equipment, from *the extreme western border of eastern civilization* to the Pacific, as the exponent of that practical experience of the railroad-builders of America, which, if never officially called to the treatment of this public question, has shown such admirable results in the extension of lines through thinly populated regions, even when harassed by the unscrupulous management of speculative parties. I present it as a simple proportioning of means to the end required; and as a restriction of the undue expenditure of the money of the people in the solution of a national problem.

For, (returning to the first point of this argument,) if, by the constitution, Congress is compelled to defend California against aggression, and regarding the settled policy of this government, forts and standing armies are not deemed the preferable means of military defence; if, as is stated by the first military talent of the nation, California *cannot* be practically defended by the means at present within the disposal of government; if a wagon-road is unsuited to the rapid

transportation of weighty supplies, forces, and munitions of war; if the construction of a Grand Trunk railway is a ponderous and dangerous experiment, and its eventual completion beyond the limits of reasonable anticipation; if the iron rail and locomotive engine may be made of immediate use, and solve this necessity by the mere adoption of a route of transit over which it can be profitably extended; then the building of this railroad to the Pacific, applicable to the exigencies involved, the amount of transportation required, and the remuneration which will ensue, is a legitimate and warrantable undertaking, because no other will answer the purposes of the case proposed. It is the extension of a railroad of the least cost in the first outlay, because built through an uncivilized country, over an undeveloped route, and as subject to the contingency of total loss to its projectors if elaborated beyond the stringent needs of the mere requirements of necessity, before reaching the distant terminus from which a revenue is anticipated—the extension of a railroad to solve the correctness of this anticipation of revenue, and, under the nature of an experiment, to test its value; but, beyond all these minor requisitions, the extension of such a railroad as the comprehension of other and more important national considerations will alone warrant constructing. It is, in like manner, the adoption of a route which, from the nature of the surface passed over, and from the avoidance of great obstacles, will lead to the immediate consummation of the project.

If the use of the rail prior to the actual completion of the road, by the mere selection of a route over which it can be extended by light grading, seem to the unprofessional observer impracticable and absurd, to the experienced railroad-builder, who has seen the working locomotive and material train made the grand vehicle of transportation over unfinished lines and upon every variety of surface, this mode of transit will at once sustain its important character in relation to the peculiar necessities of the present case.

The road would consist of a T-rail, of sixty pounds to the lineal yard, spiked to a wooden cross-tie, and adjusted to a ditched and drained surface. But, as it progressed, it would be liable to modification by those improvements which inevitably occur, and which, in view of the constructive faculty of this nation, should not be lost sight of in preliminary arrangements.

Over portions of that broad central division of the continent, reaching from the Missouri river to the Pacific, the mountainous, broken, and undulating country bears a very small proportion to the extent of elevated plateaux, either level or of slight inclination to the horizon. These elevated plateaux offer substrata of sand or gravel, easily excavated, slightly affected by the action of frost, and, by nominal reduction of surface, affording a road-bed of perfect drainage, and of superior quality for the preservation of superstructure and machine, and also favoring those simple manual operations deemed sufficient to keep American railway lines in working order. A railroad line passing over such a surface would as far transcend all means of transportation by plank or wagon-roads as is possible to conceive. It would admit a speed of twenty miles per hour, with loaded trains, over the greater portion of its distance, and at least the passage of loaded trains over all portions of its distance.

It would appear as a direct exemplification of capital reserved. *The whole amount of its cost would have been expended in the mere needs of transportation for the purpose of building the proposed Grand Trunk road.* Attempted without its aid, the construction of the Grand Trunk road may be regarded a chimera; and even if eventually completed, the depreciation and renewal of its superstructure and rolling stock, the loss of interest on dormant capital, and the disastrous results attending its consummation, would thrice exceed the entire cost of a preliminary road.

The mere development of territory would remunerate the cost of constructing a road, only attempting in every stage of its completion a character or medium adapted to the simplest requirements of necessity; while no such minor sources of revenue would warrant the construction of a first-class line or road assuming an elaborated character from the outset.

ROUTES.

For a Pacific railroad, the term *route* will cover the extreme breadth of country to which side examinations may reasonably extend, or to which any claim of location may carry a line by detour. The term *route* in these remarks must not be confounded with the word *line*. The route of a line is (strictly) *defined by survey*. The route to which the location of a line is referrible is described by reconnaissance.

Two of the grand routes across the American continent are peculiarly adapted to the ready and rapid extension of a rough preliminary railroad. One of these routes passes south of the Sierra Nevada mountain range, and in the vicinity of the Mexican frontier. The other is that of the present emigrant road of the South Pass to California, Utah, and Oregon. Both of these routes are of flat plateau surface, and gravel substrata. Over one of them, the passage of trains would be obstructed during winter by the snow of the great plains; over the other, a northern population would be decimated during the summer by the fevers of the Gulf. Over one of them, the frosts of the northern winter would, during half the year, prevent the speedy progression of the works of construction; over the other, the miasmas of a southern summer would prove fatal to the health of the Celtic laborer. Over the northern route, pure water can be delivered from abundant sources of supply, at sufficient height above the rail, to be furnished at low cost for the use of locomotives; over the southern, it must be procured by more expensive methods, from fountains difficult of access and limited in quantity. The northern route is longer than the southern, but, of central position, it can be more readily defended in the time of war. Contiguous to provision and labor-producing States, it can be more cheaply constructed, and, when built, will command and unite important and conflicting public and private interests. Long sections of both routes are destitute of timber, which can only be supplied by the use of the iron rail. Both of them differ from all other routes across the continents. Both are better suited to the speedy extension of an effective means of military transportation by railway than any others. Both are especially worthy the attention of government in the selection of the route of a road for the purposes of military defence; but neither of them would so readily attract the notice of speculators in land grants, nor is either particularly adapted to the development of great agricultural interests.

As the salient requisition, which gives government constitutional power to act in the premises, is that of military defence, and the leading feature of that requisition is early communication, the first step towards the solution of this intricate problem of overland communication is narrowed down to the choice of one or both of these routes; the subordinate or latent characteristics which subsequently come forward in the domestic relations, of development of inland territory, and of procuring the influx of western commerce, not being confounded with, but in every respect kept distinct from, the peculiar and striking national feature which first won the attention, and is now strenuously urged as entitling this undertaking to the full notice of legislation.

The most southern of these routes being beyond the field of the present report, I bring this whole view of the engineering merits of the question as giving great character to a forked road, which, reaching by a main stem from the central border of eastern civilization to the Mormon settlements, would there permit of the connexion of a short branch line to Puget Sound, and of the extension of a main trunk to California.

This road, as first extended, would represent the word *line*, as *delineated*, or placed by the requirements of location, by the trace of actual survey, for preliminary service. But, as eventually elaborated, it can only be described, at the present time, by the report of reconnaissance, as within the limits of all future claims of location by the word *route*. The rough road, built for the purpose of military transportation, must be placed, by engineering study, over a surface adapted to rapid extension, and be adjusted with great care at water crossings, summits of

country, and all positions of a character to postpone early consummation. But it may, nevertheless, become the means of constructing a grand line, not necessarily contiguous to it, as the term would be applied in civilized regions; for, reaching by any line of approach, the vicinity of the plains and rim of the Great Basin, where occur sources of supply of iron, coal, building materials, and way-stations of population, a preliminary road would become the carrying line for developing and transporting these resources.

To once more state this question. It is probable that Col. John Charles Fremont (not particularly a railroad-builder) is better qualified than any other individual to name the relative merits of the several lines of central routes, regarding agricultural development, from having compared them in the field. The direct line from St. Louis to San Francisco—which is located too far south to admit of ready connexion by a branch with Puget Sound and the important northwestern coast—is described by that distinguished explorer as possessing such characteristics. It has attracted national notice as a grand central Pacific line. Its adoption has been advocated by one of the oldest statesmen of America. And these desultory remarks are for the purpose of explaining that the combined extension of a wagon-road and preliminary railroad over the present emigrant trail of the South Pass, would in no degree prevent, but would, in fact, absolutely further the completion of a grand highway of commerce and of nations over the direct line named, which, central in reference to commercial and domestic relations, is not central as regards the combined claims of California, Oregon, Washington, and Utah, or of the entire Pacific coast, for military defence; and under the contingencies of rapid railroad construction, could not conscientiously be selected for such a purpose by legislation.

This view of the question should also practically refer to all routes of such undulating and broken surface as to postpone *early* communication, if adopted.

A military railroad should extend over plateau surface, from the mere fact that a railroad is not a line of fortifications, but a structure peculiarly pregnable to the most insignificant means of attack; and, when built over substrata of sand or gravel, the line of communication can be renewed, when broken, at a few hours' notice.

The energy of the American people has never yet failed to develop border country by railway. Legislation has seldom hesitated to aid the construction of roads, even in advance of the needs of civilization. But (summing up the statements of this paper) if nature has debarred any section of the continent those facilities of surface or position which warrant the attempt at rapid railroad extension, in answering this grand necessity of the earliest practicable consummation of overland transportation, then the requirements of a whole nation should not be made subservient to such merely local claims to attention.

If local roads can only tardily progress over a rich agricultural, but broken surface—a surface of excavation and embankment, of masonry and bridging, of practicable construction but of deferred communication—while the less costly preliminary line might be speedily extended toward the mountains, then the claims of the hardy pioneer of civilization, of the citizen of California, Utah, Oregon, and Washington, should not be deemed subordinate to the prayer of the wealthy capitalist of the eastern city. If legislation is to furnish the means of solving this problem of overland communication, the rights of the poorest herdsman of the Pacific are as much entitled to notice as those of the eastern speculator in land-grants.

THE CONSTRUCTION OF THAT FIRST SECTION OF A PACIFIC RAILROAD CONTIGUOUS TO THE STATES, THE INITIATIVE OR PRELIMINARY STEP TOWARD THE EARLIEST PRACTICABLE CONSUMMATION OF THE WHOLE UNDERTAKING.

During the many long discussions which have taken place on the subject of a railroad to the Pacific, it seems to have been forgotten, or to have entirely escaped notice, that all great railroad lines are built in sections, and that, although this road is one of two thousand (2,000) miles in length, yet but a single mile need be built at the outset.

The argument that the difficulty of selecting a route prevents such a conclusion need not be entertained, if the route is chosen on the constitutional grounds of the cheapest and earliest consummation of the military defence of the Pacific possessions by overland railways.

If the whole question of the construction of a permanent road to the Pacific resolves itself into the prior construction of a railroad to the Pacific of less elaborated character, so too the construction of a preliminary railroad to the Pacific resolves itself into the building of the first mile of the very first section of the best route for that road adjacent to the border settlements.

The first section of the main stem of the forked route of the emigrant road does not, however, commence at the first unfinished portion of the Pacific railroads (so called) of Iowa or Missouri. The two hundred and fifty miles of severe undulating surface extending between these lines of rail, now tending west, and Missouri river, is of a character to prevent early completion; and the people of the Pacific coast and the present claims of the nation will not permit awaiting the three, four, or five years it will require to bring these roads to Missouri river.

Neither can it commence at Fort Kearney, which is the proper point of intersection of all eastern lines. This point is as far inland toward the west, and wagon-roads will not furnish the cheap and rapid transportation required for weighty materials of construction.

From the peculiarity of surface offered—a surface graded and ballasted by the act of nature—the first section of the pioneer railroad of the emigrant plateau route must be supposed to commence on Missouri river, near the mouth of the Platte.

As the navigation of the Missouri, as high as this point, is ample for the transportation of rails, equipment, and furnishing, the road—finding its own means of rapid extension—would reach the mountains, over the flat sandy surface offered, at about the same period of time that the local roads of Iowa and Missouri were completed, to become its connecting links with eastern lines—say in three, four, or five years.

The line (of five hundred (500) miles length) would traverse the edge of a range of low sand-hills, skirting a broad and fertile river valley, which reaches, without a break in surface, from the mouth of the Platte to the first broken country of the great grazing section of the Black Hills (so called).

Under the present system of legislation—the aiding of the extension of railroads by speculations based on the augmentation of the price of government lands to the actual settler—reasons might be offered why Congress can assist in the construction of this road of five hundred (500) miles on far more equitable grounds than have hitherto led to the multiplication of rivaling and competing roads across the border.

The fact that this line *would* become the first section of a Pacific railroad, and the needs of California, Utah, Oregon, and Washington find a place in a discussion which has hitherto been devoted to those of Texas, Arkansas, Missouri, Iowa, and Minnesota, or the wealthy capitalists of eastern cities, is probably the cause why this line could not thus be aided.

The following domestic relations entitle it to notice, without reference to the fact that it would become a section of the Pacific railroad, viz:

While other divisions of the public domain are favored by navigable waters, by which the appliances of civilization may be transported, the narrow belt of fertile soil which this line traverses can only be laid open to the pioneer by the passage of a railroad. Like many of the richest regions of the west, the country is sparsely wooded; and during the growth of wood, (by keeping out the prairie fires,) fuel and building timber cannot be transported for the use of settlers by the insufficient means of a wagon-road.

The needs of better means of transportation than this route now affords have become so great, that it has been proposed to secure them for the benefit of the Mormon settlements, by building a canal from the head-waters of Yellow Stone river toward Utah, and by a detour of over three thousand (3,000) miles of river and canal navigation.

The construction of the road would shorten by five hundred (500) miles the distance now travelled by the overland emigration, and prevent the great loss to the nation in domestic stock

which yearly occurs; and the value of which, thus saved, would pay the interest on the whole cost of building it.

To secure the advantages of becoming the sources of supply to emigration, settlements would grow up at the mountain terminus of the line. These settlements would become some of the most important of the nation. They would soon furnish those supplies to transportation which, in event of war, would make the defence of the Pacific coast a practicable measure, by the farther overland passage of trains by a wagon-road. The citizens of a narrow State would defend and support their railroad. The border population, thus placed five hundred (500) miles nearer the Pacific, would soon reach the outlying farms of the Mormons. Intercourse would take place with that singular people, and the weight of public opinion tend toward solving an intricate problem in the science of self-government.

All these results can be obtained by the construction of a railroad at lower cost than any line now in operation in America, of equal length.

The road is on the grand approach to both the Bridger's Pass and the South Pass of the Rocky mountains. It is the main trunk of the whole great overland travel going west of those mountains. It is most advantageously situated, regarding the connexion of eastern lines. At a point near Fort Kearney, at the head of Big Island of the Platte, roads from Lake Superior, from the pine districts of Minnesota, from Lake Michigan, at Chicago from the central roads of Indiana, from St. Louis and the South, can favorably intersect with it on equal terms.

These roads can there drain the traffic it has developed, and their trains make passage over it to the mountain terminus and the interior. The road would become, in its artificial relations to Kansas, Nebraska, and Utah, what the great rivers of our country have been in their natural advantages to the country east of the Mississippi; or, as all navigation ceases at the Missouri, a deficiency of nature would be supplied by the triumphs of human ingenuity; therefore, the general government might reasonably afford to aid the construction of this first section of a great railroad line in its passage towards the Pacific, where, full of important connexions, like the branches of a river, its arms extending upon either side, it would develop not only the narrow region which it traverses, but the resources of distant localities, and become to the western portion of the American continent what the Ohio and Mississippi have been to the eastern.

THE CREDIT SYSTEM OF CONSTRUCTION.

In the course of these remarks, I have repeatedly referred to the credit system of construction.

The construction of the pioneer or preliminary, rather than the permanent Grand Trunk road, will restrict the evils of this system to the minimum; and a mode in which the road might be built would, in a measure, prevent their occurrence. Without presuming to suggest to the attention of legislation the evils which, in my own belief, will inevitably follow the literal overworking of the land-grant system of construction, when the stock market becomes flooded with the scrip of unfinished roads, I will refer to the credit system as connected with the subject of a railroad to the Pacific.

Returning to the legitimate discussion of this question, I shall endeavor to maintain the position, that even the construction of the first section of a Pacific railroad should not be made to labor under the liabilities of the land-grant and credit system of building.

The conduct of the preliminary step in a series of experiments which shall test a great national project, and, in a measure, define its character, should be simple, effective, and guided by judicious deductions from former experience.

The railroads of the United States are *actually constructed* by building contractors, under the direction of civil engineers. These building contractors take the works from other contractors, who are great stock operators, and are often even directors of the company they bargain with. The companies are generally formed in the following manner:

A very small amount of stock—say 30, 40, or 50 per cent. of that required—is raised by local parties along the route of the line. These parties (farmers, mechanics, merchants, and land-holders) thus form the basis for the schemes and management of the operator, who takes the residue of the stock. Both company and operator are now at the mercy of the agents of the great capitalists of the country. By holding such amounts of stock, the operator in many instances controls the directors' board, or even changes it at his will, by the votes of proxy. When, by capital raised, borrowed, and furnished, the road is partly or wholly graded, it is then mortgaged or bonded for iron and equipment. The running of trains now takes place, and the road, still in an incomplete state, is turned over to the company. About this period of time the able operator decides whether to dispose of or retain his interest in the line.

A few years ago, when many of the lines of the country were first opened for travel, this plan of building occupied a very high place in public estimation; but, since these roads have begun to wear, and the costs of renewal, of closing the open construction account, and of running trains at non-paying rates have opened the eyes of stockholders, it has, in a measure, fallen into disrepute.

Very few of the roads of the country will now more than pay the interest on their bonds, the original stock subscription or basis being in most instances totally absorbed.

But it is, nevertheless, undoubtedly true, that the farmers, mechanics, and land-owners, who took the initiative and lost their original stock, are actually reimbursed by advantages gained. All sections traversed have been augmented in value, and, in the majority of cases, (always excepting the crises of monetary liabilities,) the country generally benefited.

By the land-grant system of credit construction, after small outlay, the lands donated by government become the basis of a borrowed capital, which is devoted to the extension of the road; the security given to government being the preliminary construction of a portion of the road. It is not necessary for me to describe a system so recently within the treatment of legislation.

As applied to a Pacific railroad, its results would appear in the creation of a greater and more powerful monopoly than has ever yet affected the business relations of this nation. The placing of the rapid extension of this national road under the necessity of public appreciation, affecting and affected by the monetary transactions of the country, would tend to produce those crises in the stock-market, to which the pecuniary affairs of this enterprising people have always been so peculiarly liable. But, without referring to these disasters, it is plain that if, during the progress of this road, public appreciation is once lost, all credit will be withheld, and a clear, simple, readily-defined engineering problem will appear in the light of a false, visionary, and chimerical speculation.

The cause of the adoption of the old credit system of construction was from absolute poverty of means; the reason of the continuation of the great monopoly of the land-grant system is because its evils are not yet sufficiently developed to be perfectly understood; but why either plan of building should be applied to retard the construction of a Pacific railroad, I am at a loss to learn.

If there is any power of the constitution by which government *can* aid this undertaking, on the grounds of military defence, neither poverty of means, nor any plea of expediency, conspires to place the project in a chimerical point of view, and no such course should be adopted to further the needs and desires of speculation.

Dismissing the idea of the Grand Trunk road, which is an experiment, the subject of inquiry is, whether the pioneer or preliminary railroad shall be used for military defence in lieu of the wagon-road. To still further divest the project of chimerical features, a surface or route is sought where, by proper management, the use of the rail can take place without material cost in grading. The selection of such a route reduces deterioration without paying business to the minimum, and enables government to procure an approximate estimate of cost. Or, more plainly, over either of the plateau routes of the continent a railroad can reach the Pacific in seven years. A road in common use needs renewal in superstructure and rolling-stock in seven

years;* but the pioneer road having, within this period of time, reached the supposed paying business of the western terminus, a general through traffic would begin to balance wear and depreciation.

Government is amply able to construct the road by cash payments. The need of the nation is immediate. To place the undertaking under the liabilities of borrowing, and to subject it to the fluctuations of public estimation, is to retard it. To retard it when once commenced, is, in a measure, to defeat it, or, at least, to indefinitely augment its cost. To create a moneyed monopoly, which will undoubtedly harass the stock-market, by an unrestricted paper issue, is to infringe upon the legitimate currency of the country, and has not hitherto been thought constitutional. We may, therefore, most certainly affirm that the land-grant system should be applied to the Pacific railroad undertaking with great caution. As the very intricate and peculiar questions of loss of outlay by deterioration, and by working without revenue over a route of extreme length and novel character, may not yet be perfectly understood, I will once more allow myself to repeat conclusions offered.

I distinctly state that *if* routes exist across the American continent over which communication can ensue with a Pacific terminus in seven years, government should take no action to delay the communication beyond that period, but should aid the construction of roads over these routes only by cash payments.

But as there are many other routes across the continent, which are fully practicable, but, by passage of undulating surface, need excavation and embankment, bridge and culvert masonry, ballasting and drainage, before the rail can be made of use, and as these tedious operations (without reference to tunnels and mountain sections) will postpone communication, however attempted, government need not necessarily feel compelled to aid the construction of such lines by the direct application of cash capital.

Hesitating to bear the risk of private experiments to procure the influx of western commerce over these lines, Congress might with reason sufficiently endow them against loss of running trains through undeveloped country, and against cost of renewal during their twenty years' progression toward the Pacific.

This aid, however, should only be bestowed in sections; for, in the present instance, it is entirely out of place to endeavor to anticipate those contingencies of the future, which are in the course of solution by experiment, and which, within ten years, or less, will be completely solved by the completion of the more rapidly extended preliminary line.

Having now placed this subject in every point of view of which I believe it capable, I will again refer to the construction of the first section of the preliminary road on the constitutional grounds of military defence.

HOW THE CASH SYSTEM OF CONSTRUCTION MIGHT BE APPLIED.

As this road is to be aided on the grounds of military defence, it is in some measure a government work.

To favor the proper dispositions on Missouri river and along the route required for the purposes and supplies of military defence, it should be built under the direction or with the cooperation of military engineers. To secure the efficient management and able practical knowledge of private parties, it should be forwarded by contract.

The line of location of the route should be *placed*, from Missouri river to the mountains,

* This is a broad conclusion. T-rails of 70 pounds the lineal yard have been known to wear in two years. I have seen, in my own experience, the edge or chair-rail and the lightest class of U-rail wear ten years without need of renewal. The weight of the engine, the inclination of gradients, the nature of earth passed over, the care given to keeping line and level in "surfacing up," (technical terms,) the rates of speed, and the number of trains run, all affect this estimate, which is approximate and not in excess.

by military engineers, to the furtherance of rapid extension, and not for the purposes of private border speculations by contractors.

Iron rails and equipment should be deposited, by the water transportation of the Missouri river, at some point best favoring the most direct approach to the main Platte valley by light grading. This point should be selected by government engineers during preliminary arrangements; and the sources of supply of building and working materials should then be retained, from location of private parties, for the use of the road.

The first section of five hundred (500) miles should be placed under contract requiring its completion within three (3) years from date.

The expense of grading the road will be merely nominal, and is not sufficient security for advances by government. To require a very large deposit in money, might embarrass the operations of the active parties (the *real* railroad builders and mechanics) who should be called upon to construct this work by contract.

From the favorable nature of the surface passed over, iron rails are necessary to the purposes of construction at the outset. As of high cost, and not liable to depreciation in value below a certain estimate, railroad iron should be regarded as equivalent to a deposit in bullion, and be accepted in lieu of moneyed security, or security by grading.

A laid superstructure, capable of sustaining the tread of a first-class locomotive engine at a speed of twenty (20) miles per hour, should be provided with simple working equipment, turnouts, and watering stations, before any payment is made to contractors.

From the point on Missouri river to Fort Kearney, near Big Island of the Platte, the road might properly consist of the common T-rail, of 60 pounds per lineal yard, spiked to a wooden cross-tie, and extended over a ditched and drained road-bed of the clear gravel of the section.

From this point of intersection of all eastern lines, (see sketch,) near Big island, a different class of structure might be attempted, at the option of the engineer. Just beyond this point, the great untimbered section, reaching toward the Rocky mountains, would be entered by the line.

Government might make payments of $10,000 per mile for the first and for each succeeding one hundred (100) miles of road completed, if expedited to the satisfaction of the directing engineers. On reaching the western terminus of the first section of five hundred (500) miles, government to pay to private parties such sum as shall have been agreed upon by a first contract, based on proposals issued, and thereon concluded with responsible bidders; government to reserve the right of cancelling the contract and taking possession of the road during progress of the work, upon equitable grounds, or upon failure of contractor to perform obligations.

Such a road sold at public auction would always guaranty first outlay. When completed (the first section) it would become the outlet and carrying line for the building of a Pacific railroad over any central route.

It would, therefore, be readily accepted by private parties in lieu of further cash payments (beyond the first $10,000) by government. But, from its important position, this road should continue to be within the general control of legislation.

As extended over the route of emigration, the building party could afford to keep up, beyond mere working supply and material trains, a medium equipment for common service; and government would not be called upon as a donating power to bestow immense land-grants on speculating individuals, to guard them against loss by running trains and depreciation of way over a non-paying route.

Government could make all payments by issuing scrip in applicable sums. Certificates to bear interest, and be payable within a limited number of years.

Public lands sold to actual settlers along the line would, in the meantime, take up all scrip issued by government. The sale of these lands should not become a governmental speculation. They should be furnished to the pioneer at the very lowest rates, and the settlement of the route traversed be promoted by every practicable method.

Sections of this narrow strip of valuable territory should be reserved for the growth of timber for the use of the road.

The company building this road, and encountering the risk of testing this first step of an experiment, should be admitted to the single legitimate speculation of having donation and pre-emption fee of a limited quantity of land at station-grounds, but not to interfere with actual settlers.

All speculations *should be brought to the best engineering line for the road. The road should not be carried from its proper engineering position to further any speculation whatever.*

In the present instance, the engineering line is that which will best favor the most rapid extension of the iron rail to the mountains. The summit-ridge between the mouth of the Kansas and the Platte is an obstacle to be encountered by a junction line, but not by the preliminary road.

The favorable features presented in the above plan would be in the competition of the ablest actual railroad-builders in the nation to construct this road under the scientific direction of individuals educated and trained at the expense of government for the service of military defence.

In event of war, this country will rely on her system of railroads for defence. By the revolutions of human progress, the Pacific railroad is especially an arm of national defence.

The military engineers of the country should have practice in this new branch of service; and as government is to furnish a portion of the means for extending this road, the scientific department to which is intrusted the erection of military works should not be debarred from participation in its construction.

The practical energy of the civil engineers of the nation will at once turn toward the consideration of this project, and appear among contracting parties; and the basis of the plan of construction offered, however modified, will serve to blend these important branches of an eminent profession in the solution of a national undertaking.

CONCLUSION OF INTRODUCTORY REMARKS.

Making no excuses for the many repetitions and the desultory character of these introductory remarks, which I have conceived necessary for placing this subject where it may be treated as a practical and scientific problem, I will now apologize for having sometimes been betrayed into a style of more earnestness than should properly appear in the statement of an engineering question.

Having devoted time, health, and pecuniary means, for over three years, to the furtherance of this great object, it requires the discretion of a caution not always within the powers of self-denial to apply to it only the defined terms of lucid demonstration.

Here, on this soil, the great masses of the people, once "hewers of wood and drawers of water" to lords and emperors, are erecting an empire of grandeur, the more comprehensive from being grounded on the broad basis of popular rights.

They are making deeper foot-prints on the path of civilization than any nation of the globe.

They are true to their own destiny, to the claims of human progress, and to the example they have become to the toiling white men of the earth.

They are inspired by the first sounds of approaching danger, and they have seen the necessities of an occasion.

They have beheld the surface of the Pacific whitened by a commerce which takes its departure from the rude cob-wharves of a city risen from the sea.

They are true to the claims of that far-off, moving, and practical population which is a part of their union, and from which they are divided by sterile deserts and snowy mountains.

They know that, by the simple triumphs of human ingenuity, these obstacles may be spanned by a Pacific railroad.

They are bound to that distant population by every impulse of generosity and by every tie of the heart. The wealth of the single isolated and unprotected State, brought home to them by the husbands, the fathers, and the brothers of virtue, has permeated every hamlet of every hill-side of America.

They feel that, in these years of tearing down and building up, this undertaking need not be postponed or confounded with the obsolete traditions of the achievements of the past. Standing so sturdily upon the present, and gazing into the future, they have long ceased to cling too steadfastly to the tottering remnants of the past.

Of energies too vast to be always within the control of legislative restriction, they have never yet failed to respect the government which they have of themselves created.

To the representatives of such a people, no plea of temporary expediency, no mere anticipation of the advantages to accrue by the extension of the Pacific railroad, will justify the slightest infringement of a single provision of the instrument whereby so heroic a mortal destiny has been achieved as the present welfare of this republic. And where the views submitted for the elucidation of this report have reached the style of argument, it has been from the desire to make the engineering difficulties of this question, as affected by constitutional requirements, definitely and perfectly understood.

Any competent engineer of even ten years' practice in railroad-building, would have offered the same conclusions.

I have the honor of assuming that, if a statement were required from the scientific department to which the conduct of the Pacific railroad explorations was confided, it will not be found seriously to conflict with the conclusions herewith submitted.

CIRCUMSTANCES UNDER WHICH THIS RECONNAISSANCE WAS CONDUCTED.

The present reconnaissance was pursued as the result of the reconnaissance of the northern frontier Pacific railroad route, which extends from St. Paul, Minnesota, to Puget Sound. The extreme difficulties of that route gradually led to the necessity of seeking other location by detour, and eventually to the exploration of the present line.

This report may, therefore, be considered as offering a general recapitulation of the features of country between latitude 49 north and the Salt Lake City, and between the southernmost point of Lake Michigan and Puget Sound, regarding railway location *as affected by the peculiar character of the project of a railroad to the Pacific.*

The difficult nature of the western mountainous country traversed by the northern route had, in a measure, destroyed its character before reaching the Cascade Mountain range of the Pacific coast. It became necessary either to tunnel that mountain range at an almost impracticable pass, to procure passage to the ocean, or to surrender the line of direction, and to deflect so far towards the south as to pass through the great valley of the Columbia river. This detour south, which involved an increased distance of 140 miles, was at once decided to be the preferable line.

The valley of the Columbia was of remarkable nature; the waters of the interior had there perforated the great chain of the Sierra Nevada and Cascade Mountain range, and flowed to the ocean over the nearly level bed of a navigable stream. No engineer of practice in railway construction could fail to be impressed with the strength of the line. It was the only natural pass to the ocean from the great interior of the American continent. Danger from snow, a most formidable enemy to encounter upon the steep grades and in the deep cuttings of a mountain route, was wholly avoided. A navigable stream afforded means of transportation for weighty material. The work of construction could take place from the Pacific as well as from the Atlantic side of the continent. Large forces of laborers could be employed along the whole length of an open route, and speedily grade and perfect the road. And when the study of the question of detour reached the consideration of the merits of a rival route, then this great pass and valley became exponents in a discussion which destroyed all claims of the extreme northern frontier line to further attention. It occupied a position to command and unite the grandest interests, and to place such weight upon the scale of public opinion (fixed on the merits of all the national routes to the Pacific) as evidently to do much toward ruling the selection. Railroads from the southern waters of Lake Michigan were already in construction west, as the continuation of the great ramification of the net-work of iron which had so aided and developed the resources of the northern and middle States. All the important interests of those sections, and the capital invested in those lines, concentrated and fixed their united strength upon a route to the Pacific through a *healthy* country, practicable of solution as a problem, in the questions of construction which arose in the application of labor and the transportation of supplies. It was evident that the wealth and mineral resources of California first drew public attention to the question of a railway across the American continent. This project, aided so long by the labors of Whitney and his associates, received little encouragement until the immense trade of the gold regions, and the important interests therewith connected, added their strength to its development. Therefore, if but one road were constructed to the Pacific, it would seek the bay of San Francisco as a terminus.

But coeval with the growth of California had been that of the northwestern Territories. The great harbors of the Pacific were San Francisco and Puget Sound, of which the latter was the superior. There were seven hundred miles of coast between them. With a railroad from the east to San Francisco, it was evident that a short period of years would require the extension of a line up the coast to Puget Sound. But this was a local contingency; and how far preferable in first location was a road, the main trunk of which, extending from the mouth of the Platte toward the Salt Lake City, would there meet two great lines—one from the bay of San Francisco, the other by the valley of the Columbia from Puget Sound—resolving (by the mere choice of a location of the railroad to San Francisco) the extension of a road from the east to Puget Sound, to the mere completion of a branch road of eight hundred miles. In reviewing this matter, it will be seen, then, that the first step in the premises was an attempt to preserve the character of the northern line, already seriously affected by the severe nature of the rocky and mountainous country it had traversed, by a deflection south to the great valley of Columbia river, to avoid the necessity of tunnelling the Cascade mountains at a nearly impracticable pass. But the second step involved in the connexion was to waive all claims of the extreme northern route to notice, until a distinct route between Puget Sound and the southernmost waters of Lake Michigan was examined, that a comparison between the two routes, or broad divisions, might be instituted; and in the meantime to distinctly state to the nation that the primary object of the extreme northern exploration, which was the finding of a facile and favorable railroad route of minimum distance between eastern navigable waters and Puget Sound, had in a measure failed, having been surrendered to procure location. This was the plainest and most definite view of the question.

The superior and distinctive feature of an extreme northern route to the Pacific was the apparent short distance between the navigable waters of Lake Superior and Puget Sound. This distinctive feature was seriously modified by the fact that the harbors of Lake Superior were frozen or obstructed by ice during a large portion of the year; and that during that period a railway terminating so far to the north would debouche directly into foreign or Canadian roads, and being, therefore, more particularly the requirement of a foreign than a national interest, might more properly exist as developed by the investment of foreign rather than of American capital. This presumption was guarded against by the connexion of the northern route with the Mississippi river at St. Paul, Minnesota, and by direct connexion with railroads already constructed through central American territory at the southernmost point of Lake Michigan.

But the distinctive feature of the extreme northern route to Puget Sound, which was the shortest distance between termini, having been surrendered to procure location, the distance between the southern shore of Lake Michigan and the western terminus appeared no greater upon the southern than upon the northern route to Puget Sound.

It would not, then, be a warrantable procedure to extend a railway over the extreme northern route to Puget Sound, and so near an exposed frontier, unless it offered superior facilities for developing national territory, or for ready railway construction. But a line passing along the frontier was not in a position to develop national territory; and regarding railway construction, "nearly impracticable" obstacles had already directed examinations further south.

The last presentation of the problem was the engineering feature, and to this requisition the examination of the new route from Puget Sound to Lake Michigan was distinctly referred. In the development of this engineering requirement, the opportunity of a connexion with the great northern or central route to California was disclosed.

When the latter consideration came into the study, it concluded argument upon the subject, since it reduced the completion of a railroad to Puget Sound to the mere construction of a spur line from the vicinity of the South Pass to Puget Sound.

It will be seen, then, that the whole question had changed in its character, and, no longer presenting a certain paramount claim to notice, became affected by interests, in no degree subordinate, as engineering and national considerations were brought to bear upon it. The subject

of a railroad to Puget Sound no longer lay under the contingency of a terminus upon Lake Superior, or the distinctive claim of the shortest distance between termini, but became distinctly referrible to the location of a road to California—a proper view of the prospective development of the northwestern Territories tending to place the national route to California in a position to afford a favorable connexion to a branch railroad to Puget Sound; and the engineering requisition being reduced to finding a practicable line by which this important result might be accomplished.

But this information was needed at once—"prior to any final action of Congress on the Pacific railroad question," and without the delay of communicating with the East, or organizing a costly expedition; because, *should* a decision occur upon the Pacific railway question previous to such information being offered, the difficulties existing upon the extreme northern route would evidently defeat that project; and, should a railroad to California be placed too far south to favor a branch connexion, have a fatal effect upon the interests of the important northwestern Territories.

It therefore became necessary for some professional party to attempt this examination, without regard to preliminary formalities, and with sufficient faith in the good sense of the community to justify the reasonable expenditure required.

The whole experience of my professional life had been to demonstrate that the comparison of great divisions of country, regarding railway location, did not involve the costly equipment of ponderous expeditions, but really referred to the amount of information gained; and that the extension of a line of odometer distances and astronomical stations in the vicinity of a proposed Pacific railway route, although a highly important, was by no means an absolutely necessary procedure to obtain the features of the country regarding facilities for construction; that the general tendency or direction of a route might be preserved by minor observations, by the aid of which could likewise be pursued the important labor of reconnaissance.

It was also deeply impressed upon my mind, that the only result of the northern exploration in the examination of the entire western division,* extending from the Rocky mountains to Columbia river, had been a mere demonstration of what was needed in the premises; and although a ponderous and costly expedition had passed through that mountainous country, this result might be traced to the labors of a few small parties.

A like result (regarding only the railway question) could readily be secured, prior to the next session of Congress, upon the southern route.

Therefore, (under a unanimous vote of both branches of the legislature of Washington Territory,) I commenced an examination of the route by the Southern Pass on the 18th of March, 1854.

The party organized for conducting the exploration was very small. Three of the men accompanying me had already crossed the mountains with the northern expedition; two of these were soon disabled, and left at the agency of the Upper Umatilla river, during the first reconnaissance of the Blue Mountain range. Saddle horses were procured of the very first class, some of which were lightly packed with the mere necessaries of subsistence. Spare horses were driven loose, and reserved for side examinations. It was proposed to cover a wide extent of country by side-work; to limit the observations to mere railway statistics, and to leave the more elaborate delineations of surface to future survey, should the route prove highly practicable.

As the reconnaissance was conducted early in the season, when the soil was heavy with recent rains, and the weather severe in the mountain passes, and as the party passed directly through a hostile Indian country, its success must be attributed, in the one instance, to the manner in which the men were mounted and the number of spare horses provided; in the other, to the

* This has no reference to the labors of the coast division.

use of Indian presents, and to the habit of constantly seeking the hospitality of the Indian camps.

All examinations of reconnaissance upon the more northern exploration to Puget Sound had been connected with a base line, the position of which may hereafter be determined by instrumental observations. Those of which the present report is the result, were connected with the line of the great emigrant trail to Oregon and California, and with positions defined by topographical surveys.

A series of meteorological observations were conducted from Columbia river to the mouth of the Port Neuf river, (establishing the relative height of mountain passes and great planes of surface of the branch line,) but they were necessarily discontinued at the Port Neuf, from the breakage of the barometer with which they had been conducted. Near that point connexion is made with the observations taken by Fremont, which extend to Missouri river. I have already referred to the mere relative value of the barometric profile, as furnishing a lineal section with which side examinations can be connected. I am indebted to the patriotism of Dr. John Evans, geologist of Oregon and Washington Territories, for the furnishing of the instrument to which I allude, which, at the time of my departure, was the only barometer to be procured on the northwest coast.

I am also under obligations to the same able and scientific explorer for reliable information of the great valley of Snake river, north of the Blue Mountain range—information which proved of great service to me in expediting the progress of the reconnaissance.

REPORT.

Referring to the accompanying sketch for a delineation of the lines described, I will now report on the salient character of that portion of the important forked route to which I have repeatedly referred, which extends from Puget Sound to the plains of the Great Basin, and in a more general manner on the succeeding sections of the route between the plains of the Great Basin and the Mississippi river.

It will be readily understood that that portion of the route between Puget Sound and the plains of the Great Basin is the northern fork or branch of any central railroad to California.

In describing the lines of this first portion of the route, I will term the belt of country extending from Puget Sound to Fort Boisé (see sketch) the first division; and that extending from Fort Boisé, through Snake River valley, to the plains of the Great Basin, the second division.

From Seattle, on Puget Sound, to a point near the Dalles of Columbia river, all lines are common to both the northern (that of the 47th and 49th parallels) and the southern (that of the present report) routes to Puget Sound. From that point to the approaches of the Blue Mountain range on the river line (see sketch) to the Pass of the Walla-Walla, undulating grades of thirty-five (35) feet to the mile may be adopted to save work. The actual approach must be made at fifty (50) feet. In the continuation of the river line north of the Blue mountains, the approaches can be adjusted at forty (40) feet per mile, and some difference of grade be adopted to save work.

By the line from the vicinity of the Dalles, skirting the high country south (to avoid river bridges and severe cuttings of low summits near the Columbia) by detour and by "side-hill approach," the first rise from the river valley will probably require grades of not less than fifty (50) feet per mile. All work in the vicinity of the valley of the Columbia is of costly character; but on reaching the surface of the plateau, at the base of the Blue mountains, grades of thirty-five feet may be adopted. All these details of location will be studied in future survey, and the line chosen which shall seem best applicable to the summit of the pass and its approaches.

From the summit of the first Blue Mountain range, the whole country toward the south is distinctly visible. The connecting spur between the Blue mountains and the great Cascade range, near the source of the Des Chuttes or Fall river, appears perforated by the headwaters of that river, and presents a low depression in their vicinity. The line of detour to which I have last referred, (see sketch,) rising by the valley of the small stream near the Dalles, and skirting the mountain base, would develop some of the richest country in Upper Oregon, and, through the pass of the headwaters of the Des Chuttes, could make connexion with a route to California, by a descent to the plains of the Great Basin in a due southerly direction. The last-named route is not within the province of the present report. A line of such direct southern tendency should preferably pass west of the Cascades, and through Willamette valley and the gold regions of the coast.

A descent east from the pass of the Walla-Walla can be made by skirting the valley of the Grande Ronde river toward the south, and thence crossing the summit between the Grande Ronde and Powder rivers, by a system of curvature approach—the change of direction from a tangent of at least one thousand (1,000) feet—and the curvature of mile radii. The descent toward the waters of Powder river can be made by skirting the broken country south, (or nearer

the headwaters of that river,) which is the apparent location for a Grand Trunk road, assuming the most direct line between termini.

After crossing the summit between Grande Ronde and Powder rivers, the route can either skirt the base of the same hilly country toward the south, and which extends in an easterly direction to the valley of the Burnt river, or pass down the valley of Powder river to the Snake. Either location is practicable—the former the most direct, and the latter the least severe. The character of grade and curvature is favorable upon both, although continued rock-cuttings will occur near Burnt river upon the former, or southern line.

Both routes are designated upon the sketch.

The former, or southern route, can still skirt the mountain base, and, crossing Malheur river, six miles from its confluence with the Snake, preserve an easterly direction toward Fort Boisé and the broad valley of the Snake. The northern can keep the valley of the Snake, and by side-cutting gain a road-bed through this valley, which, in the immediate vicinity, does not offer so favorable facilities for railway construction as exist a few miles farther east. Either of these routes, hereafter assumed as a grand location line, will need care in adjustment, the engineering problem resolving itself into the "keeping up" of grade, or making facile descent from the pass at the head of the Walla-Walla, by skirting the Grande Ronde valley, and thence by skirting the broken and mountainous country south, avoiding too sudden and abrupt descents and ascents of the various water-drains of this mountainous country flowing toward the great valley of the Snake, and which occur in the crossings of the Powder, Burnt, and Malheur rivers.

Fifty miles of country, extending west from Burnt river, is severe, but of a nature which reducing the character of the line, by adjusting either steep gradients or sharp curvatures, cannot obviate. Fifty per cent. of the work is rock-cutting at short haul, spurs of ledges which cannot be avoided, but with no bad summit section. The work is so placed, that large forces of laborers could be applied to it. At prices of excavation in New York and the eastern States, this 50 miles of line could be readily reduced to gradients of 40 feet per mile, and a road-bed of 35 feet, (which admits of a first-class line, with double track of wide gauge, properly ballasted and drained,) at $100,000 per mile. This is the severe ledge section of the line east of Columbia valley, and extending to the Great Basin. The summit section of the Walla-Walla will undoubtedly prove deep ledge-cutting, and may require tunnelling, but its approaches are of 80 per cent. earth.

From the valley of Burnt river to Fort Boisé no great difficulties of location or construction will occur.

The route, by detour through Snake-river valley, would possess features of a decidedly more favorable character, as traversing a gravel surface. In reaching the country in the vicinity of the Powder river, the route north of the Blue Mountains would occupy common position with the most northerly of the lines upon the sketch, or continue down the valley of the Snake. Side-cutting would occur in the latter instance for a distance of twenty (20) miles, or would be avoided by forming a road-bed of the débris of the neighboring basaltic ledges, which are near the mouth of the Burnt river, and jut down upon the line. For the purpose of keeping a road elevated in approaching the higher plateau west of Fort Boisé, the line should encounter the ledge-cutting. This would render the road more expensive at the particular section, but would reduce cost in advance. No deep rock-cutting should occur upon a preliminary railroad. The line could be temporarily adjusted to make passage of this unfavorable point for first transportation to the interior, and, when the obstacle is reduced, the main route supersede the preliminary one.

The description of the second division of the route from Puget Sound to the plains of the Great Basin may be briefly summed up, as the extension of a line over a broad gravel surface, at merely nominal cost of grading, all questions of location being readily solved. The connexion between the southern plateau of Snake river and the valley of Bear river was obtained

by passing up the valley of the western fork of the Pannack river, and over prairie surface of clear gravel formation, to the waters of a small stream seeking an outlet in the Roseaux, or southern Malade, a tributary of Bear river. Three very practicable passes were examined in this vicinity; and of these, that to which I have first alluded is the superior. The character of the country, as ascertained by an examination of both the northern and southern bases of the northern rim of the Great Basin, admits the practicable passage of railway lines between Snake river and the Great Basin at numerous low passes dividing this range north and south. The topographical sketches of country in this vicinity, taken by the late survey of the Salt Lake basin, are very characteristic, and define its features with great fidelity. Passage can be readily made north and south, but is not so facile at angles to that direction. The lines are designated on the sketch. The technical description of the first division was entered into as affording information to future survey, and is of slight interest to unprofessional parties.

BLUE MOUNTAIN RANGE, AS CONNECTED WITH ABOVE DESCRIPTION OF LINES.

My exploration of the Blue Mountain range was first directed toward the headwaters of John Day's river (so called); and the approaches proving of more serious character than first anticipated, I was then led to confine myself to approaches of more practicable nature near the headwaters of the central fork of the Umatilla. To the latter pass, which is termed that of the Young Chief's Trail, I gave a very thorough and careful examination, from the result of which I am compelled to pronounce it impracticable for a *Pacific* railroad.

By barometric approximation, the summit of the Blue Mountains (the Young Chief's Trail) is 4,650 feet above the sea. Railway summit at head of lowest swamp, 4,393 feet above the sea; by the character of the "approaches" involving twelve (12) miles tunnelling, and continual water-drift.

When such obstacles (encountered at a distance from civilized communities) can be avoided by reasonable detour, no claim of direction should style them practicable in comparison.

This result affords no grounds for a judgment against the pass of the Walla-Walla, delineated on the sketch, which has been known for years as a low passage of the Blue Mountain range.

It is situated at the head of the numerous branches of the Walla-Walla river, and in the vicinity of the remarkable valley of the Grande Ronde.

It should be made the line of passage of these mountains by a main road, but I have proposed the extreme northern passage of the great valley of the Snake for a preliminary railway.

IN REFERENCE TO THE SELECTION OF A TERMINUS AT PUGET SOUND—FIRST SECTION OF LINE.

In recapitulation, I shall state the merits of these divisions regarding construction, dividing the first division into three distinct sections.

In reference to the choice of a terminus on Puget Sound, I will quote the language of Captain George B. McClellan, chief in charge of the western division of the northern exploration, a military engineer of practice and ability, whose opinion on the selection of a great harbor on an isolated coast, needing thorough protection by the erection of suitable fortifications, is entitled to more consideration than any which I could myself offer as a civilian. The opinion of Governor Stevens concurs with that of Captain McClellan; and the experience of both gentlemen in their peculiar branch of service places the selection beyond a question.

Captain McClellan states: "I have mentioned Seattle as the proper terminus for the road, whether it crosses the mountains by the main Yakima, or by the Columbia-river Pass. This place is situated on Elliot bay, and is by far superior to any harbor on the eastern shore of Puget Sound."

"Seattle is the nearest to the straits of Fuca. It is easily entered with any of the prevailing

winds; is secure from heavy seas, and has a most excellent holding-ground of blue clay, and a good depth of water—thirty fathoms. The banks are suitable for a town; the deep water comes so near the shore that but very short wharves will be required. Semi-bituminous coal can be found within fourteen (14) miles by water. The harbor can be defended by permanent fortifications."

From Seattle to Vancouver, a distance of one hundred and sixty-five (165) miles, (round numbers,) twenty-five (25) per cent. of all grading will consist of high prairie plains of light soil—embankments built by side-work in easy gravel shovelling. Fifty (50) per cent. of work, extended plateaux of heavily timbered country; low, wet surface; deep, black soil; embankments built by long haul, with gravel trains. Twenty-five (25) per cent. of work, undulating surface of equalized cut and fill; fifty (50) per cent. of the latter is ledge excavation at short haul; no deep cuttings; no gradients of over forty (40) feet per mile; curvatures of mile radii, readily located; minimum amount of masonry; stone suitable for rubble-work at Puget Sound. Brick clay reported in abundance, but not seen by engineer. More than average facilities for railway construction at reasonable cost.

FROM VANCOUVER TO THE DALLES OF THE COLUMBIA, A DISTANCE OF NINETY (90) MILES.

Not less than fifty (50) miles of heavy embankments exposed to the action of water in the great freshets of Columbia river; to be formed by borrowing, in the broken débris of basaltic ledges, a material abundant throughout the river valley; the weightier blocks to be placed at their natural slope upon the face of the embankment; forty (40) miles of equalized side-cuttings and embankments; the excavations averaging 70 per cent. of ledge. No gradient exceeding 15 feet per mile, unless at the discretion of the engineer. Curves of 2,000 feet radius, and a reverse within 200 feet of tangent point from intermediate straight line; or a tunnel of 700 feet at the mountainous point, termed Cape Horn, but avoided by preliminary road. Maximum amount of rough masonry: first-class bridge-masonry at a crossing of the Columbia, 1,200 feet in length; stone suitable for rubble-work, if combined with brick-work, may be procured in vicinity of line. Brick clay occurs in abundance in vicinity. A fine variety of mountain pine, suitable for all timber structure and tressel-work in vicinity of line. First step in grading, the construction of the road around the falls or cascades of the Columbia, to connect water transportation. The whole section of 90 miles to be assailed during first labors of grading, that supplies and material may be transported to the divisions of the interior. A severe and costly section, requiring the experience of first-class engineering faculty for proper reduction at reasonable outlay.

FROM THE DALLES OF THE COLUMBIA TO SNAKE RIVER, NEAR FORT BOISÉ—GENERAL APPROXIMATION OF FACILITIES FOR RAILWAY CONSTRUCTION OVER WHOLE DIVISION.

Fifty (50) per cent. fair gravel-work; equalized excavation and embankment, at reasonable average haul; 30 per cent. of ledge in side-cutting. Summit sections, 30 per cent. hard material; (loose rock and hard pan;) 20 per cent. of all gradients 50 feet per mile; room for reasonable adjustment of curvatures of 2,000 feet to one mile radius; abundance of first-class timber for all structures to vicinity of Powder river; brick clay in quantity near Powder river; abundance of boulders, affording suitable material for all minor masonry in vicinity of Grande Ronde and Powder rivers; granite in quantity near Burnt river; brick clay near Malheur river; at mouth of Malheur river fine granite suitable for masonry; near Fort Boisé excellent material for masonry in various localities; some timber, with facilities for boating or rafting, upon the great tributaries of the Snake river.

The western portion of this section affords fair opportunity for railway construction at reasonable cost. The problems of construction readily solved, experience in location being mainly required to give the line its best position over such broken, undulating country. Should the

line pass to Fort Boisé, by detour towards the north, through the valley of Snake river, gradients would be materially reduced, and this broken country, in a measure, avoided.

From Fort Boisé to the valley of Bear river, the route is of nearly uniform character. The line would traverse a high gravel or sand plateau, requiring mere nominal grading to prepare it for the rail. A few spurs of the hilly country towards the south extend toward Snake river, and can be encountered by the line, and reduced at low cost, or readily avoided. The changes in level are very gradual, and occur in broad terraces of many miles in extent, gradually rising toward the eastern mountains.

Brick clay occurs in quantity upon Katherine creek, (so-called.) The scarcity of wood in the vicinity would prevent its use; but the extension of a preliminary road over the broad surface of these level plateaux would transport all necessary material to any section required, at low cost. Sufficient timber exists in the vicinity of the line (a species of mountain fir upon the hilly country south, and stunted cedars upon all low summits) to allow the ready extension of a line of rail, by the laying of a cross-tie and rail upon the level surface.

This section preserves its character in approaching the summit of the dividing range between the waters of the Snake river and the Great Basin. The approach is very easy, and the summit itself is an elevated gravel plain. By gradually approaching along the mountain side—the position of which allows the adjustment of the line by regular curvature—this summit can undoubtedly be accomplished by a cutting of thirty (30) feet in gravel, and gradients not exceeding fifty (50) feet per mile. A preliminary line could be extended over it, without more excavation than necessary for the adjustment of the superstructure. The descent to the plains of the Great Basin is more difficult than the rise from the valley of Snake river. It may be readily accomplished, however, at low cost.

The whole country is open. From surrounding summits, the inclination towards the Pass and entire line of approach is distinctly visible. The route is remarkably favorable for railway location and construction. The chief difficulty to be apprehended, is from the scarcity of timber, both in the immediate vicinity of the Salt Lake, and over the whole section extending to Fort Boisé. This difficulty must be obviated by the use of a preliminary road; for the construction of which, suitable stone for masonry is found on the northern rim of the Great Basin. Timber occurs in average quantity in the mountains north of Snake river; for all the purposes of a preliminary line, it can be obtained in the vicinity of the route.

From the need of the construction of a preliminary road to complete any railroad to the Pacific within a reasonable time, I shall therefore state that this second division of the route, or section extending from Fort Boisé to Bear-river valley, or to the plains of the Great Basin, presents extraordinary facilities for the construction of a railroad at minimum cost; and that in the comparison of the engineering features of the lines from Puget Sound, in an easterly direction, to Bear river, upon this southern, with an equal distance upon the northern route, the advantage is immeasurably in favor of the southern line.

It may be reasonably affirmed, from this result of reconnaissance, that the extension of a railroad line from the Great Salt Lake City to Puget Sound, or from the route of a railroad from California to Puget Sound, is eminently practicable. The character of Columbia-river valley is severe; but it should be borne in mind that it is a pass or passage of the Sierra Nevada or Cascade mountains, and is therefore merely to be weighed in comparison with other passes, as incurred by all other lines. It is common to both the northern and southern routes to Puget Sound. It is the most severe section upon the southern, but by no means the worst section upon the extreme northern route.

I may observe, in this connexion, that the Grand Pass of the Yakima river, or the Snoqualmie Pass, to which so much attention has been given upon the northern exploration, is in far better direction in extending the southern than as a continuation of the northern route to Puget Sound. By a glance at the sketch, it will be observed as occupying a direct line from the Walla-Walla to that terminus.

Should future instrumental survey demonstrate the section to be more practicable than is now anticipated, it will be a source of pride and gratification with me to withdraw any expressions of opinion I have offered on the subject, and to claim the location thus developed as giving still greater character to the southern route to Puget Sound. It must necessarily appear, however, that during the excavation of the deep-rock cuttings and long tunnel of this summit, communication should be extended to the interior; and I should most emphatically advise the development of the Columbia valley, by cheap railway facilities, to afford such communication. The cheap or rough railway to be extended to the interior by detour from direction north of the Blue mountains, and through the Snake-river valley, to the extensive plateaux east of those mountains—solving the problem of construction at low cost, and existing for the period of years required to construct the more direct route of the Walla-Walla and Powder rivers, as a full solution of the Pacific railway problem.

CONNEXION OF BRANCH ROUTES, AS ABOVE DESCRIBED, WITH THE VARIOUS CENTRAL ROUTES TO CALIFORNIA.

Connexion can alone occur with the straight route of the 38th and 39th parallels from St. Louis to California, (that advocated by Colonel Benton,) by extending the branch line from Puget Sound along the eastern shore of the Great Salt lake, and by the line of the Mormon settlements to the vicinity of Little Utah valley—an entire distance, in round numbers, of 1,200 miles from Puget Sound.

Should the Pacific line reach California through the Bridger's Pass, the connexion of the branch road could take place on the plains of the Great Basin near Salt Lake City, by a route of 1,050 miles from Puget Sound.

But should the line to California adopt the route of the South Pass, a line might be adopted which would afford opportunity for the connexion of the branch road to Puget Sound by a route of 875 miles. In the latter instance, the Pacific project would be restricted to reasonable limits, and to the least cost in first outlay which will afford results desired.

My estimate of the cost of a branch line will be confined to the intermediate length of line of 1,050 miles.

ESTIMATES OF COST.

All approximated estimates of cost upon the route from Puget Sound, *via* the South Pass, to the Mississippi river, must necessarily be confined to the branch road from Puget Sound to the plains of the Great Basin—the continuation of the reconnaissance toward the Missouri not being of a character to admit of more than a very general statement of the features of the section passed over. This general study of the route is, however, fully sufficient to demonstrate its merits regarding facility of construction as a railroad line, as compared with the more northern route. The material of excavation, readiness of reaching mountain sections, character of surface, &c., &c., will appear in a general comparison herewith given.

No estimate of the cost of a Pacific railroad can be deemed reliable, from the remarkable contingencies which must inevitably occur during the consummation of the project, and serve to defeat what may at present appear quite warrantable conclusions on the nature of the question and the cost of the road.

I resolve the whole question of the construction of a railroad to the Pacific, in present estimates, to the mere extension of a railroad to the Pacific, of unelaborated character and of medium equipment; *not in broken, or temporary working sections*, but actually making connexion between eastern lines of similar gauge, and eastern water transportation, and a Pacific terminus. The connexion with terminus, and the passage of trains, without breaking bulk, along the whole line of the road, giving greater character to the conviction I have so often directly expressed,

that the construction of a preliminary line will lead to the most effective solution of the question in its manifold relations.

When contiguous to settlements, and under due prospect of remuneration from way business, this line need not necessarily be confined to a preliminary character; over no section encountered in the passage of the continent, necessarily confined to any peculiar character or class, save as under attendant liabilities; and, while always subject to the principle of expansion, or of elaboration, as circumstances shall direct, still never surrendering the obvious necessity of the earliest practicable connexion of termini.

Should the passage of the great obstacles to railway transit—by the channels perforated through them by the act of nature, in the flowage of the waters of the interior to the ocean—be prevented for a few weeks by the freshets of the mountains, it is still assumed, in this estimate, that the use of the rail eleven (11) months of the year, during the long period while these obstacles are being overcome by the means of transportation thus afforded to supplies, laborers, and all needed appliances, will still prove a remarkable desideratum in the early consummation of the project.

Although in a detailed estimate of the cost of the northern route to Puget Sound, I submitted, by direction of Gov. Stevens, what my experience in railway construction then led me to believe would prove a close approximation to the cost of a Grand Trunk line to the Pacific, of the class of the present day, subsequent experience of the late crises in a railway mania of the country has demonstrated to me the fallacy of submitting any estimate of eventual costs of a Grand Trunk line of two thousand (2,000) miles, extending through an uncivilized country, and fully elaborated, equipped, and furnished—when built under a system of competition, hazardous speculation, inadequate application of cash capital, and as affected by discursive attempts at the construction of several Grand Trunk lines.

But a road of rough class, admitting the passage of weighty trains, and reaching the Puget Sound terminus by practicable detour, can be completed from *the waters of Missouri river to Seattle, on Puget Sound, for fifty millions* ($50,000,000)* *of dollars* in cash capital, actually expended on the construction and equipment of the road.

The following estimate for the branch road of one thousand and fifty (1,050) miles embraces a larger sum per mile, from the better class of line proposed over certain portions of the route—as probably required by adequate way business, and as more economically accomplished if attempted at the outset:

From Seattle to Vancouver, on the lower Columbia, a distance of one hundred and sixty-five (165) miles, facilities existing for cheap construction, a preliminary line of better class than would be attempted in the far interior, with a rail of sixty (60) lbs. per yard, or structure of corresponding strength, and reasonable reduction of surface, erection of rough masonry, &c., at the present prices of the Pacific coast	$4,125,000
From Vancouver to the Dalles, a distance of ninety (90) miles, and including a passage of the Great Cascade mountain chain—a line of rail of sixty (60) lbs. per yard, secured by mechanical appliances, and admitting the passage of a locomotive engine and train without breaking bulk—the temporary road-bed of ledge debris covered with water, and unserviceable during the freshets of the Columbia.	3,150,000
From the Dalles to the plateau surface at northern base of Blue mountains, including bridge of Columbia, and approach to upper plateau surface from lower level of Columbia valley, one hundred and fifty (150) miles.....	4,500,000
Passage of Snake-river valley plateau and cañons, a distance, in round numbers, of two hundred (200) miles, some portions of line unserviceable during the spring	

* With all contingencies; depreciation, workage, management, inadequate appropriations in broken sums, credits, &c., say $75,000,000.

freshets of Snake river, involving some preparation of rough surface to use best route of descent to Boisé, but with long stretches of level gravel plains.....	$6,000,000
From Fort Boisé to the Great Basin, including passage of the Pannack, by practicable detour—say five hundred (500) miles, over gravel plateau.....	9,000,000
For general approximation, say eleven hundred (1,100) miles of road from Seattle, on Puget Sound, to the plains of the Great Basin.....	26,775,000

As connected with a railroad line to California, by the South Pass and valleys of the Snake and Pannack rivers, the branch road would be subject to a reduction, in cost, of about four millions of dollars.

In the above estimates an addition of fifty (50) miles, at average cost, has been made for contingencies and probable deflections in locating a preliminary road.

CONTINUATION OF RECONNAISSANCE TO MISSOURI RIVER.

The route just described is, as heretofore stated, the northern branch of a forked route, the main stem of which extends from the plains of the Great Basin to Missouri river. The southern fork of this route, and the main trunk or stem, is termed, in the reports of the Pacific explorations, the route of the 42d parallel. Two of the lines of the route of the 42d parallel respectively extend—the one through the South, the other through the Bridger's Pass of the Rocky mountains I consider the choice between, or selection from, these two lines, the most important and interesting of the many engineering details connected with the adoption of the line of a central railroad to California. This is especially the case, if the selection is to be guided by a determination to reduce the whole question of a railroad to the Pacific to the construction of such a sort of military railroad as shall reach the Pacific coast within seven (7) years.

The statements of the Introduction to this Synopsis will now have their weight, and simplify the final engineering presumption of that paper—that Congress should hesitate to do more, at the present time, than aid the construction of those first sections of the Pacific railroad lines contiguous to the States ; aiding the first sections of routes of undulating surfaces, with reference to the needs of civilization and way-transportation, if deemed constitutional, by land-grants ; but aiding the two lines of plateau surface, extending over broad plains, with a view of the earliest practicable connexion of termini.

The following reasons are offered for arriving at such definite conclusions in reference to the route of the 42d parallel:

The first section of this route is the line of approach to both the South and Bridger's Passes of the Rocky mountains.

The examinations of these passes have been confined to reconnaissances, and have not yet been verified by survey.

By reference to the sketch, it will be seen that a dotted line is carried from the South Pass, in a northwesterly direction, to the head-waters of the Snake. This line (so far as examined) extends over a broad gravel plateau ; a flat sand-plain, interspersed with swamps and ponds of brackish water. The South Pass is nothing but an extended plain, slightly broken towards the south into an undulating country. It is the first break down of the Great Wind River mountains at the north, among which is a summit of over 12,000 feet above the sea. In this plain, and among these ponds and swamps, head the waters of the tributaries of the Grand Colorado, the Snake, and the Platte. The engineering rule—in seeking location over broad belts of surface between termini which extend at angles to the direction of great watercourses—is to skirt the country in which they head, or to pass over the lower delta where they have deposited, in broad terraces, the earth from the deep channels excavated by their flowage, rather than to adopt the intermediate region, broken by their transit. Reconnaissances for the loca-

tion of Pacific railroads only differ from those of minor lines as the broad divisions of a continent differ from the limited sections of the county and the State, and as the choice of routes is affected by the claims and contingencies of construction, brought forward by the extreme length of line to be traversed, in the wear of the road during deferred connexion of termini.

The inclinations of gradients are affected by the character and length of the approach, as much (in general terms only) as by the elevation of the summit to be overcome.

A line which reaches, by the long inclined surface of the Platte valley and the Sweetwater, the level plains of the South Pass, and thence, without surrendering height accomplished, passes over the gradual slope toward the west of the valley of the Snake, and thence, by the low pass of the Pannack, reaches the plains of the Great Basin, necessarily avoids the steep grades induced by a descent into the great valley of the Colorado, (see route 39th parallel, and in less degree 42d parallel,) and the subsequent rise over and descent from the Wahsatch mountains, to the plains of the Great Basin. The intermediate country, broken by the passage of water, is avoided by detour.

Therefore, were this surface of the swamps and sand-plains of the Great South Pass not at so great an elevation above the sea as to place it near the regions of perpetual snows, the argument would be unanswerable regarding its selection in reference to the extension of a preliminary road. This is an evident conclusion, because *the engineering requisition to be answered* is, the finding of a continued line of flat or slightly inclined surface, over which a rail may be extended to the Pacific within seven years.

But if the preliminary road traverse the plateau of the South Pass, and the long flat line of country beyond it, fully 7,400 feet above the sea, it would be exposed to the inevitable dangers and embarrassments of this elevated region, regarding snow and frosts.

To expedite preliminary arrangements, it has been proposed to use the natural surface (where of gravel or sand substrata) without grading.

Over the South Pass this could only take place during half the year. But in a more deferred mode of extension, the facile line of approach to the South Pass will permit, by the adoption of steeper gradients, of the erection of an embankment road-bed, which will in some measure guard against the obstacle of snow. Even an open structure, through which snow would drift, and over which trains could pass, might thus be adopted, or (with the surface road) a covered way under which trains could make transit. But in reference to snow, the elevation of the summits of the broken and undulating surface in the vicinity of the Bridger's Pass, are but slightly below that of the flat plains of the South Pass. The excavation of cuttings and the erection of culverts and bridges for the passage of water, would there unquestionably postpone communication, and in a measure prevent the earliest use of the carrying road. Again, every railroad employee knows the difference between a cutting and an open road, regarding embarrassments from snow. The mountaineers of this section state that they can travel over the plains of the South Pass in winters, when the gorges of the more southern Bridger's Pass line are filled with snow and impracticable of passage.

Early communication is the desideratum, and this is resolved to the most rapid extension of a preliminary railroad. Therefore, in view of the extension of a similar line as a winter road over the sand-plains of the extreme southern frontier route to California, I should give the preference to the route by the detour of the South Pass. Notwithstanding some increase of distance and of the cost of rails, it would probably be less expensive than the other, and would sooner reach the plains of Snake river and the Great Basin, and carry supplies for a working section across those plains.

But returning to the engineering presumption first submitted, we might more reasonably infer that, from the difficulty of arriving at a conclusion at the present time, this question of choice between two lines of a route should be left open. It should be determined by future examinations during the construction of that first section of the line of the emigrant road, which is the grand approach to both the South and Bridger's Passes of the mountains; although, to

prevent postponement and delay, the construction of the first section should most certainly not be compelled to await the solution of this engineering question.

The line of the South Pass, as connected with the northern detour, was only developed by my reconnaissance of the branch route from Puget Sound. Since my arrival in the States, I had proposed making, at my own expense, a thorough examination of this and the dotted line of the sketch which extends north of Snake river; but learning that it was the intention of the War Department to send an exploring party over it, I abandoned the idea of a private expedition, and offered my services to go with a small party in advance of the exploration, and aid its progress by the rapid service of preliminary reconnaissance, which, from my knowledge of the country and of the needs of the line, I thought might prove serviceable.

Between the South Pass and the eastern slope of the Black Hills, (so called,) the preliminary line would in some instances be confined to the narrow, but by no means costly, passage of the Sweetwater river, while the main route would necessarily adopt a more direct location. The whole section is of favorable character. In the adjacent mountains excellent timber can be readily procured, and first-class material for masonry exists contiguous to either line. The earth excavation is in clear gravel, of that superior quality which best preserves superstructure from the effects of severe and sudden changes of temperature, and frosts, and which gives the most perfect drainage when formed into a road-bed. Reaching the valley of the Platte, all difficulties of location cease, and a broad bottom land, falling at scarcely perceptible inclination to the very banks of the Missouri, and overlaying a substratum of clear gravel or sand, offers every facility for cheap construction.

This broad surface of bottom land breaks toward the north into ranges of low sand-hills. Clear streams flow from these low summits at irregular intervals of distance; and from the facility with which their waters can be delivered at sufficient elevation above the rail for the use of locomotives, will prove of great value to the line; the turbid waters of the Platte not being so well suited to that important purpose. In the edge of these sand-hills, and beyond all danger of freshets, a preliminary road can be extended towards the mountains.

Stone of medium quality occurs upon the Platte, and at the junction of the line with the Missouri.

I am compelled to state, however, that, with all its attendant advantages, the route through the valley of the Platte labors under what may be termed a peculiar objection to any railway line to the Pacific. Two hundred (200) miles of the distance between the first broken country and the Missouri is entirely destitute of timber, and the remaining portion but sparsely wooded with the cotton. The waters of the river are broken by sand-bars, which would probably prevent rafting from the mountains. This peculiar feature of the line should be especially regarded, from the fact that the State of Iowa, which is the eastern terminus of the route, is also scantily timbered, and that the whole upper valley of the Missouri can give but slight aid in the connexion. The northern route labored under difficulties of a similar character in its passage to the mountains, but, by changing the location after the liability was developed by reconnaissance, it may now be readily overcome by the construction of the road over the detour line of Little Falls.

A line from a point on the Mississippi opposite the mouth of St. Croix river, and extending to the Missouri near the mouth of the Platte, would deliver the superior timber of northern Minnesota and Wisconsin at the debouche of the present line, and provide the great Territories of Nebraska and Kansas with the lumber of which they are so deficient, and which the whole upper valley of the Missouri does not afford. The want of timber upon the Platte does not extend to the deficiency of fuel for locomotives. Coal of excellent quality abounds upon the Northern Platte, and evidently underlies the whole eastern portion of the routes. Less bulky than wood, it is easily transported.

Sufficient timber is now growing in the Missouri valley, and near the lower waters of the Platte, to admit of the immediate extension of a preliminary road; and, in event of its con-

struction, operations should be commenced by which the fertile country in the vicinity should be made susceptible of improvement in this respect.

The mere suspension of the prairie fires will tend to the object; but well-instituted experiments have demonstrated that several varieties of timber are readily grown from the seed upon the western prairies, and that a period of ten years is sufficient to make their results available. In connexion with the estimate of the northern route, I have been compelled to propose the planting of twenty-four thousand (24,000) acres of surface, for the mere purpose of making steam, with an additional surface of ten thousand (10,000) acres for fires in depot buildings. If such tedious operations are to be attempted, the location, climate, soil, &c., are abundantly preferable for the purpose upon the present line.

The coal-beds of western Iowa, and of the whole great section near the base of the mountains, with the existing probability of abundant supplies beneath the intervening surface, are of great importance in sustaining the character of the present route, by removing all absolute necessity of planting timber for the mere purposes of fuel.

The reduction of coal to coke for the use of locomotives may be readily attempted at those points where the raw material is abundant in deposit. The yield of the present variety would average about two-thirds of the weight of coal.

The erection of coke ovens in the vicinity of the coal district will reduce cost of transportation; and the reduction of coal to coke, which is peculiarly adapted to making steam, will prove the better economy.

The use of coke is not common in America, from the abundance of wood at the numerous way stations of all inland lines.

Experiments have been conducted upon several of the best eastern roads on the use of coal in locomotive furnaces. Engines have been constructed for the purpose of carrying out the results thus obtained; but, although demonstrated as practicable, the burning of coal for the purpose of making steam has not hitherto been thought an economical procedure. Any direct need or necessity of such an application would undoubtedly lead to its immediate accomplishment.*

A favorable bridge-crossing of the Missouri occurs at a point a few miles north of the mouth of Platte river, at the old ferry of the Indian trading-post, and adjacent to the present Omaha Indian Mission. Other crossings of the Missouri are practicable, both north and south of that point. A Grand Trunk line, assuming the most direct route from the first pass of the Sweetwater to the present bridge-crossing of the Mississippi, can procure a position farther north; and that of a route avoiding the great eastern bend of the Platte can readily be adjusted farther south.

The whole subject will be fully solved by the numerous surveys of private lines seeking connexion with the great road to the Pacific; and, in this respect, the eastern terminus of the route, which the present report embraces, might properly be located at the head of Grand Island, near Fort Kearney, where all roads of local character can make connexion with it.

REVIEW OF NORTHERN AND SOUTHERN ROUTES TO PUGET SOUND.

As I have passed over both the northern and the southern routes to Puget Sound, a brief review of their relative characteristics is not out of place. As connecting with eastern lines now

* "Coal *vs.* Wood in Locomotives.—The Boston and Lowell Railroad Company have lately been making a trial with one of their locomotives of the relative value of wood and coal for fuel. The result of the trial is reported as follows: The whole distance run was 2,366 miles, of which 1,868 miles were with freight, using one cord of wood in 26 miles, or 68 cords, at $7—amounting to $476; and 598 miles, with passengers, using one cord of wood in 30 miles—amounting to $199 51. Total expense of working by the use of wood, $615 51. The expense of running the same distance with coal, at the rate of $6 50 per ton, (the cost in Boston,) amounted to $265 46; being a saving in favor of coal of $350 05, or above one-half. This is quite an item."—*Lowell News*, 1855.

Since the completion of this report, experiments made on the Illinois Central Railroad the present year (1856) have solved this question; coal is proved more economical than wood, and will now come into general use as fuel for locomotives.

completed, they are of about equal length. The crossing of the Mississippi is already accomplished upon at least one line, extending towards Chicago upon the southern, while upon the northern it is yet to be completed. The crossing of the Missouri is yet to be attempted on the southern, while on the northern it is wholly avoided. On the northern, the crossings of the Marais, Sun, and Teton rivers, which are problems in engineering, are (as combined) more difficult than the bridging of the Missouri. The crossings of these rivers cannot be avoided by a preliminary line, and occur on the northern route before reaching the mountains. That of the Missouri river need not be attempted by the preliminary road at all. If the line of detour of the northern route, by Little Falls, is adopted—which will necessarily occur from the great needs of construction on the inland sections regarding timber—a quite elaborate process of building must take place ere the extension of a preliminary road can occur. From Little Falls to the plateau Bois des Sioux, the country "is broken and springy, needing a large increase of culvert masonry and ballasting throughout." Thence, after reaching the Great Cheyenne river of the north, the fine country of northwestern Minnesota is of broken and undulating surface, over which a constant reduction of minor summits must inevitably occur. The erection of masonry must take place, and excavations and embankments of equalized work be used in reducing a rolling country to practicable gradients. The substratum of this grand section, against which the waters of the Missouri are thrown, and turned back or directed toward the south, is of gravel and clay admixture partaking of the nature of hard-pan. It is costly of reduction, and, when placed in road-bed, must be ballasted. The need of ballasting is imperative in making use of the rail over such material, when exposed to the action of severe frosts and sudden changes of temperature. In contradistinction, the southern route traverses a gravel plain, upon which the rail can be placed without any tedious operations. By the use of practicable curvatures to avoid minor obstacles, which a locomotive engine cannot readily accomplish, loaded trains can probably pass to the broad surface west of the mountains. They can certainly pass, with very slight reduction, directly to the mountains, and, as over the main stem of both the California and Oregon routes, aid the construction of both lines west without delay. The obstructions to the navigation of the Missouri will not practicably prevent water transportation to Westport, or to the mouth of the Platte, for the southern line, but during eight months in the year will interfere with building the northern by water carriage.

The difference in the cost of constructing two first-class lines of the present day over these routes—say of two thousand (2,000) miles each—would not probably range less than twenty-five millions (25,000,000) of dollars in favor of the southern. It lies chiefly in the difference of moving the loose gravel and sand of the southern road, which, at eastern prices, can be readily accomplished (including hauling) at fifteen (15) cents per cubic yard, and of moving the harder material, with an admixture of clay and large pebbles, in some instances verging on hard-pan, and in all instances so closely packed as to require picking, of the northern route. The latter class of excavation is worth, at eastern prices, twenty-five (25) cents per cubic yard, and also requires the large additional cost of transporting clean gravel and sand very long distances for ballasting, or for the formation of a road-bed.

The difference also consists in the amount of excavation. In the one instance, the line being confined to elevated plateaux, where an excellent quality of loose, clear gravel, thrown in from side-ditches, and dressed two (2) feet above the surrounding surface, is sufficient for the rail; in the other, as passing over the before-mentioned undulating or broken surface, requiring continued cart-work and culvert masonry at long haul. Some of the best portions of the northern line (through Milk-river valley, for instance) extend over a level river bottom; but the road is prevented using such advantages by reason of spring freshets, which cause the necessity of more than double the amount of work to elevate the grade far above the surrounding surface.

In the mountain sections the difference is extreme; the severe work on the southern route being confined to a limited section, and upon the northern extending through nearly imprac-

ticable gorges. In the general grade of the roads, when completed, the preference is with the northern; that is, if the descent west from Cadot's Pass can be accomplished by side-hill location, which by great care in adjustment may occur. In sudden changes of direction, and sharp rates of curvature, both regular and reversed, the advantage is immeasurably with the southern. In practicability of repair, it is entirely with the southern. The danger of demolishment being with the northern—the latter, very great in its passage of Blackfoot and Bitter Root rivers.

In time of construction, the advantage is entirely with the southern line: immeasurably so, in the extension of a preliminary road; fully so, in the completion of a Grand Trunk line. It arises from the occurrence of continual ledge-cuttings upon the northern, where circumstances will prevent the employment of large numbers of laborers, and where the character of the work is a single face and long haul, and from the greater length of the time required for excavating rock. Both the northern and southern routes to Puget Sound possess an undeniable advantage over all other Pacific roads, with the exception of the extreme southern line—at least, over all lines encountering the Sierra Nevada mountain range—from the fact that upon these routes the line of rail may be extended from both the Atlantic and Pacific sides of the continent at one and the same time, reducing the season of opening the line of communication nearly one-half, and the cost of distributing materials for construction in nearly an equal degree. I refer to the passage of the Columbia valley, already reduced to a low grade by the action of nature.

The twenty-five (25) millions difference in cost between the northern and southern lines would construct a branch road, of medium character, from the point of junction with the California route to Puget Sound. Therefore, this question resolves itself into the following presentation: By adopting a line to California located so far north as to admit of the connexion of the branch-road to Puget Sound, the amount required to construct the spur to Puget Sound becomes a clear profit. This deduction being obvious if the northern, the line of extreme cost, were to have been adopted to Puget Sound, and a distinct route built to California.

The construction of a Pacific railroad by aid to private parties, is alone within the limits of a rigid interpretation of the powers of the constitution, when the development of what must necessarily appear a project is confined to the mere completion of a road of unelaborated character, as a means of military defence, or is confined to such length of route in local sections as to remove from it the character of an experiment. But as a means of military defence, a railroad should not pass along an exposed frontier, where it would necessarily incur the hazard of needing protection by augmentation of the standing army.

It would seem that the resolution of this project, north of latitude thirty-nine, to the construction of a line of reasonable cost, touching at the important way-station of Salt Lake City, with a main trunk extending to California, and a northern branch reaching Puget Sound, through the Grand Level Pass of Columbia valley, was the presentation of the question as a mere national undertaking in its salient points, as connecting and defending isolated territory at minimum cost. Even as an experiment, (if such an experiment is to be made,) by passing over the great route of emigration to Salt Lake City, Oregon, and California, developing the Territory of Nebraska, through the great valley of a river entirely unnavigable, admitting an important connexion through Kansas, with Westport and St. Louis, while solving the question of Indian defence by the transportation of troops and supplies, at a few days' notice, to the far interior, it would seem that the building of the first section of a railway, at the low sum of twenty-two thousand five hundred ($22,500) dollars per mile, (see Introduction,) might be deemed a warrantable undertaking; were it never to extend beyond the mountains. But should this line then pass to the valley of Snake river, and at length reach Puget Sound, transport the supplies of western commerce toward the east, grow up commercial emporiums at that

western terminus, and defend and develop the isolated Territories of the north, it would in itself exist as a solution of the Pacific railway problem.

Yet, traversing broad gravel plateaux, both east and west of the dividing range, if attempted in a proper manner, it must speedily reach its destination, and the important spur through the low pass of the Pannack be as rapidly pushed to the base of the Sierra Nevada, and the vicinity of those severe and costly works which should be at once undertaken at the favorable point for a passage to California. At the mere nominal outlay of its construction, even for national defence, such a road might be deemed a *necessity*—the cheapest and the best means of restraining the savage tribes, and providing facilities of approach to the Pacific, the very knowledge of which would prevent the aggressions of an enemy.

For when, by the aid of the genius of American engineers, even the Autocrat of Russia unites his extended possessions by the construction of military railroads, it is a suggestion to the policy of a free people, whether they do not hesitate too long in adopting that means of rapid communication, which will continue to confine the military operations of the country to their present simple and effective character. Forts and standing armies were once deemed national means of protection, but now methods of defence may be made the causes of aggrandizement.

When a city is the growth of a year, and the passage of an ocean but a fortnight—when the newsboy cries the morning message of the telegraph, and the aged man is whirled through space by the flight of the locomotive—when the farthest settlements of a mighty nation are still the children of one great republic, indivisible and forever to be united—then, as I have already stated, and will continue to assert, the military road can no longer be deemed the passage of a hill-side, or the crossing of a river; but it must become the means of rapidly moving the suddenly organized forces of that volunteer soldiery which have made the wars of America immortal, to the utmost verge of her remotest borders. How important, then, should become the choice of location for such a road, and of what paramount consideration all that shall tend toward the expediency of constructing it—its prospect of remuneration to private, its means of augmentation to public interests, its opportunities for cheap grading and for early reaching its destination.

I have already shown that, by the proper location of the branch road from the Missouri, or from Grand island to the St. Peter's, the Upper Mississippi and St. Croix, northern Minnesota and Wisconsin may be drained of their rich lumber upon the line of this southern and grand central route, aid in its construction, and find a market for a valuable home product absolutely needed in Nebraska, Kansas, and Utah. This branch road would eventually reach Lake Superior. Again, should the great interests of the Canadas persist in their efforts to construct a distinct Pacific railroad along the northern frontier, either north of the severe mountainous country of Washington Territory, or by the route of the United States northern governmental expedition, as it is now proposed, to secure the trade of the Pacific ocean to the valley of the St. Lawrence—then the Northwestern railway, from Chicago to the Great Bend of the Missouri, would drain a portion of the traffic of this line toward central American territory; and it is certainly more expedient to build a Minnesotian American railway, to tap the carrying trade of a British Pacific road, than to build an American road over nearly impracticable mountain ranges, to be drained of its business, on reaching level country, by a British line.

For this reason, the aiding of the construction of a local railroad from Chicago, *via* St. Paul, on the route of the northern exploration, is worthy of the direct notice of government. Such a road would develop a section as fertile as any other of the public domain. It would connect the waters of the great Red River of the North with the Mississippi; it would carry the lumber of eastern Minnesota to the grand unpenetrated divisions of the northern bison ranges, and furnish the means of extending a hardy population to the very limits of the cultivable eastern sections. This road would extend over a rough surface, but, in developing this rich agricultural country, could progress as fast as required by the needs of the civilization which would keep pace with it.

The aiding in a different manner of the first section of the main stem of the Platte Valley line, or, as regarding the surface passed over, in reference to more rapid extension, would resolve this question to its salient points, north of latitude 39.

Finishing, then, the comparison of these two great routes to Puget Sound, I will conclude by remarking that, while the impracticable nature of the western mountains shuts the northern route from the Pacific terminus, it was the very facility of connexion with the Pacific that first gave character to the southern. While the one passes along exposed frontier for a distance of fifteen hundred miles, and in direct vicinity of a great navigable river, the other becomes, for over half its length, the main trunk of a more important road through central American territory which is entirely undeveloped. The one has been reduced to a local; the other is still a national requirement. Upon the one, facilities for communication can only exist by artificial means; upon the other, they are already abundant by the act of nature. The lumber of the north is needed in the south; connexion with the west is claimed by the east. The northern route affords neither, and the southern route offers both. I claim, then, the question for the southern.

No elaboration in office of the rough data of field reconnaissance can entitle them to be regarded as the results of survey.

The profile of the map transmitted, although comparing favorably with that of other routes, does not delineate the actual railroad line.

When the preferable route of a Pacific Railroad is selected, by the comparisons of reconnaissance, the location line of that route will be placed, by careful instrumental survey, and it may then be accurately delineated; but the lineal section of barometric levels, with which the side examinations of reconnaissance have been connected, must not be supposed to occupy that position. Presented as the profile of a route, when *not* accurately placed, it will lead to erroneous conclusions on its merits; and even *when* accurately placed, the mere approximations of the instrument used do not furnish a result regarding time nor undulations of surface. Again, from the small scale on which a profile of two thousand (2,000) miles of line must be presented, the remarkable differences between the flat plain over which the rail may be used without grading, and the broken country, which needs costly and tedious operations for reduction to grade, are not perceptible.

Two examples may be given:

The height of the Pass of the Walla-Walla, (Blue mountains,) compared with the level of the Grande Ronde valley, both measured by Colonel Fremont, on the common emigrant wagon-trail to Oregon, would show it as impracticable for a railroad; yet, the approach to that pass, by the side-hill location—afforded for over forty (40) miles, by which the grade of the road is "*kept up*" and never allowed to descend to the level of the Grande Ronde valley at all—shows the fallacy of presenting the profile of the wagon-road as that of a railroad line. Again, in the second instance, a profile of the extreme northern route would show (on paper) a flat, or slightly inclined surface, approaching the Rocky mountains on the east, and descending from them on the west; whereas, in reality, of the country on the east, the greater part of the line is undulating and of slopes, over which the locomotive engine cannot pass without grading. On the west, the line shown on the profile would appear of facile gradients; while, on the contrary, from being confined to almost impracticable mountain gorges, to adopt such gradients the road must absolutely lie in the beds of torrents, where occur freshets of thirty (30) feet in height. The barometric profile is serviceable in showing the relative height above the sea of the grand divisions of the route, as follows:

The plateau at the western base of Blue mountains, a point to which the South Pass line is readily brought by gradients of (in excess) 50 feet per mile is above the sea	3,426 feet.
Thence by the northern detour line, say	4,000 "
By eastern approach to Blue mountains, Pass of Walla-Walla, side-hill line	4,112 "
General level of first grand plateau of Snake river	3,050 "
Second grand plateau	4,201 "
Mouth of Port Neuf	4,409 "
Summit of line of rail at South Pass	7,490 "
Plains of Great Basin, southern connexion line	4,200 "
Level of general eastern approach, through the valley of Sweetwater river, to South Pass	5,000 "
Fort Laramie, Missouri river	1,280 "

These heights as above the sea, in proportion to the lengths of route, (not given) are in excess. It would be entirely out of place to apply the equation of grade by maximum loads to the ascents and descents of this route, as compared with the northern route. The northern route is emphatically a line of ascents and descents; of undulating grades, which are not shown by the data of preliminary reconnaissance, but would (with full through traffic) materially add to the working length of the road. It would be preposterous to apply such equations to the profile of the emigrant wagon-road, or make the profile of the wagon-road the basis of a detailed estimate.

CONCLUSION.

The broken falls and rapids of the Snake river, near the mouth of the Salmon (see sketch), were measured by the barometer.

The water falls 328 feet in a distance of 15 miles.

At about (by the river) sixty-five (65) miles above these falls occur those of the Shoshonees (so called). They have been rarely visited by white men. At a distance of 12 miles, a white column may be seen in the plain, resembling the smoke of a fire. The sound of falling water is heard at a greater distance. The bed of the river is six hundred and twenty (620) feet below the surrounding level country. The water flows in a contracted channel of about four hundred (400) feet. The sides of the ravine are nearly perpendicular. The fall is one hundred and eighty-five (185) feet, and is slightly broken at a point fifty (50) feet from the upper level. Five hundred (500) yards from the foot of the fall occur rapids of eighteen (18) feet.

The height of the American Falls, near Fort Hall, is fifty-four (54) feet.

The exploration would have been still more extended, had the party retained its first effective organization. Of the whole number of men who accompanied me from Oregon, but a single individual arrived with me at the Missouri river. This individual, Mr. J. F. Moffet, had conducted the meteorological observations of the extreme northern expedition. He gave his attention to the same duty under the more trying circumstances of the recent exploration. He was a native of Virginia. He had educated himself from the proceeds of his own industry; studied as a lawyer, and was admitted to the bar of Washington Territory. In the performance of his last patriotic service, his system received a shock from which it never recovered; and he died, of the privations incident to a passage of the continent without the comforts of a train, after his arrival at Missouri river.*

I am indebted to Mr. R. R. Thompson, Indian agent of the Umatilla; Mr. J. T. Jeffreys, of

* Mr. Moffet left a small family unprovided for. If the exposure and hardships of the frontier citizens of America are of too common occurrence to gain public attention, the exemplary conduct and resolution of this gentleman, ending only with his life, are entitled to this passing notice.

Oregon, and Captain Hector McArthur, late Hudson Bay factor near Fort Hall, for valuable assistance. Leaving my own tired party and worn-out horses in camp, Captain McArthur accompanied me, with a single half-breed, in a long reconnaissance of the numerous passes of the upper rim of the Great Basin during many days' forced marches in hostile Indian country, and continued exposure to violent storms of snow and sleet.

I take this public method of acknowledging my obligations to the officers of the military stations of Vancouver and the Dalles for the courtesy and assistance received from them in organizing the expedition.

All of which is respectfully submitted by

FRED. W. LANDER.
Civil Engineer.

WASHINGTON, *July* 21, 1856.

[This Report has been revised since its first transmission to the War Department.]

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

REPORT

OF

EXPLORATION OF A ROUTE FOR THE PACIFIC RAILROAD,

NEAR THE

THIRTY-SECOND PARALLEL OF NORTH LATITUDE,

FROM

THE RED RIVER TO THE RIO GRANDE,

BY

BREVET CAPTAIN JOHN POPE,

CORPS OF TOPOGRAPHICAL ENGINEERS.

1854.

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WASHINGTON, D. C., *October* 17, 1854.

SIR: I have the honor to transmit herewith a report and maps of the survey of a route for the Pacific railroad, near the thirty-second parallel, from Red river to the Rio Grande.

My instructions required me to examine also the military features of the route; and in this fact, and the short time at my disposal, is to be found my apology for the voluminous character of the report.

I am, sir, respectfully, your obedient servant,

JNO. POPE,

Brevet Captain Top. Engs., in charge of Exploring Expedition.

Hon. JEFFERSON DAVIS,

Secretary of War, Washington, D. C.

CONTENTS.

CHAPTER I.

Page.

Methods pursued in determining the data upon which are based the maps and report of the survey..... 1

CHAPTER II.

General description of the country along the route..... 5

CHAPTER III.

Of the Indian tribes..... 13

CHAPTER IV.

Military character of the route..... 18

CHAPTER V.

Agricultural and mineral resources of the route..... 25

CHAPTER VI.

Of boring or digging for water on the Llano Estacado..... 35

CHAPTER VII.

Construction of a railroad along the route, and its estimated cost..... 39

CHAPTER VIII.

General summary, business of the road, &c..... 47

APPENDIX.

A.—Diary of the expedition, by J. H. Byrne, assistant computer:

CHAPTER I.

From the Rio Grande, at El Paso, to the Pecos, at the thirty-second parallel..... 51

CHAPTER II.

From the valley of the Pecos to the Sulphur Springs of the Rio Colorado of Texas..... 59

CHAPTER III.

From the Sulphur Springs of the Colorado to the Clear Fork of the Brazos..... 73

CHAPTER IV.

From the Clear Fork of the Brazos to the valley of the Red river..... 86

B.—Preliminary report on the natural history, by Spencer F. Baird..... 94

C.—Report on the specimens of soils and mineral waters, by Jas. C. Booth..... 95

Page.

D.—Note, on the geological report 98
E.—Table of camping places along the direct line of survey 98
F.—Tables of meteorological observations 100
G.—Table of latitudes, longitudes, and magnetic declinations 104
H.—Table showing the altitudes of stations above the sea-level 105
I.—Observations for determining profile from El Paso to Preston, on Red river 108
J.—Observations for determining the profile from the Emigrant Crossing of the Pecos to the Big Springs of the Colorado. 111
K.—Observations for determining the profile through San Augustine Pass of the Organ mountains 111
L.—Tables of astronomical observations 112

BOTANY.

Report on the botanical collection, by Dr. John Torrey and Prof. Asa Gray 157

GEOLOGY.

Report on the geology of the route, by William P. Blake.

REPORT.

CHAPTER I.

Methods pursued in determining the Data upon which are based the Maps and Reports of the Survey.

To enable the department to judge advisedly of the amount of confidence due to the results of an exploration of this character, it would seem proper to set forth the organization of the exploring party, and to describe in full the instruments used and the methods pursued in determining the data upon which these results are based.

As the object of this exploration was eminently practical in its character, and had in view the investigation of a specific question, I have thought it advisable, in determining upon a plan for the report, to give the prominent place to the practical results which have a direct bearing upon the construction of the railroad, and to set them forth under proper heads, as briefly as is consistent with clearness. For this purpose I have carefully avoided embarrassing the subject with a narrative of the daily incidents of the expedition, which must be more or less irrelevant, or involving it in obscurity by the introduction of detailed descriptions, under scientific and technical names, of the specimens collected in the various departments of science. I have only introduced into the reports such extracts from these subjects as are necessary to illustrate some point having an immediate and important bearing upon the question of the railroad, and have collected into an appendix the diary of the expedition and the reports upon the geology, botany, and natural history of the route.

Method of determining the geographical position of the route.—Of this duty I took charge myself, and the following plan was adopted: Seven principal points were selected along the line, as nearly at equal intervals as it was possible to place them, and at each of those points the latitude and longitude were carefully and absolutely determined, by a complete series of astronomical observations. The sextant was the only instrument I had for this purpose, and it was therefore necessary to determine the longitude by the method of "lunar distances." At least seventy lunar distances of the sun, and of stars east and west of the moon, were observed at each principal point; and the latitude was determined in all cases by at least one hundred and fifty altitudes of stars north and south of the zenith. At each of these points the chronometer was carefully rated by observing equal altitudes of the sun, and altitudes of east and west stars, for several successive days. Twenty intermediate points were determined along the line by at least sixty altitudes of north and south stars for latitude, and twenty altitudes of east and west stars for the error of the chronometer. As the rate of the chronometer was carefully determined at each principal point, and the chronometric longitudes of intermediate places were referred directly and at short intervals to the points thus absolutely determined, the time observations may be considered as furnishing at least very close approximations. Twenty-seven points along the route, at intervals not to exceed twenty-five miles, were thus astronomically determined; and as the observations exhibit no error on their face, and the results determined by the computations of several able and experienced computers are in all respects satisfactory, the position of the line of survey may be considered fixed with some considerable degree of

accuracy. I have also, in the preparation of the maps, used some determinations of latitude and longitude made by the boundary commission and by Colonel J. E. Johnson, of the topographical engineers.

For tracing the line of survey over the short distances between the astronomical positions, the compass fixed in position was used, and the lengths of the compass courses measured with a viameter, which had been carefully compared with the measurements by the chain. As all error in measurement or bearing was confined to the short distances between the fixed points, the details of the route may, I think, be considered sufficiently accurate.

All the astronomical observations, with the results of the computations in each case, are appended to this report. The instruments used were—sextant, eight inches diameter, by Gambey, Paris; chronometer No. —, by Parkinson & Frodsham.

Determination of the profiles.—The profiles of the route, and of the experimental lines on each side of it, were determined by a continuous series of angles of elevation and depression, observed with a theodolite. This method is unusual in the survey of lines so extended, and is a much more detailed and tedious process than that usually adopted.

Although liable to errors in the determination of absolute altitudes above the sea-level, this method is probably more accurate than that by the barometer for determining the relative heights of points not remote from each other; and covering, as it does, every foot of the route, it exhibits every feature of the country and every undulation of its surface with a detail absolutely unknown to any process other than that of the level.

The results, which have been compared at a few particular points with barometric determinations, exhibit an approximation sufficiently close to be convincing of their general accuracy. With this duty, in connexion with the compass courses of the route, and of the prominent features of the country contiguous to it, I charged Lieutenant Garrard, 1st dragoons, my principal assistant, and he executed it with a zeal and ability worthy of every commendation. A table of the observations, with the deduced results, is appended. The instruments used were—theodolite, made by W. & E. Jones, London; odometer, for measurement of distances.

The following maps accompany the report, viz:

1st. A general map on a scale of ten miles to one inch, or $\frac{1}{633600}$, exhibiting the route surveyed, and the country contiguous to it. The lower side of the map is faced with a profile of the route from El Paso to Preston, on the Red river. On the left side will be found a short profile from Doña Ana to the Hueco Tanks; and on the right, a profile from the emigrant crossing of the Pecos to the Big springs of the Colorado. These profiles are made upon the same longitudinal scale as the map, with a vertical scale of 2,000 feet to the inch, or $\frac{1}{24000}$. As the line of survey has nearly an east and west direction, the prominent places on the map will be found to be nearly above corresponding points on the section, which can thus be easily referred to for the altitude and grades.

Map No. 2. A map and profile of the Guadalupe Pass, on a scale of 5,000 feet to the inch, or $\frac{1}{60000}$; vertical scale of profile, $\frac{1}{6000}$.

Map No. 3. Map and profile of the pass through the Hueco mountains, on a scale of 5,000 feet to the inch, or $\frac{1}{60000}$; vertical scale of profile, $\frac{1}{6000}$.

Geology and geological profile of the route.—It was impossible to secure the services of a geologist to accompany the party; and it became necessary, therefore, to adopt some method for collecting specimens in this department of science, which would enable a skilful geologist, who had not been over the country, to arrive at a sufficient knowledge of its geological structure. The plan determined upon was in every respect satisfactory, as will be seen from the geological report. Specimens were collected from the strata of the ridges and mountain-ranges, from all outcrops, and from the surface of the ground and beds of streams, and were labelled as follows: first, locality; second, distance from summit; third, position of the stratum from which it was taken relatively to the others, and its inclination to the horizon. Many specimens of minerals

and of mineral water were also collected; and the results will be found fully set forth in the forthcoming report of the geologist to whom they were submitted.

Captain C. L. Taplin, my second assistant, was charged with the duty of making this collection, and its successful results are a sufficient evidence of his industry and intelligence.

Botanical department.—The collections in this department of science were not restricted to what was new or undescribed, as I considered it quite as interesting to know that the flora of this region were the same as those common to other parts of the country, or that they were different. It was, therefore, established as a rule to collect everything; it being as easy at the conclusion of the survey to reject what was superfluous, as it would be difficult to replace what was wanting.

A complete collection of the grasses of the country was made, as their quality and quantity had an immediate and important bearing upon the determination of its agricultural character.

The entire collection, which is large, was made by Dr. W. L. Diffenderfer, who accompanied the expedition as surgeon and naturalist; and has been submitted for examination to Dr. John Torrey, of New York, whose interesting report upon the subject will be found in a supplementary volume.

Natural history department.—The collections in this department were divided among several persons.

The birds and small animals, which required careful preparation to be safely transported, were prepared and arranged by Dr. Diffenderfer; and the collection of fishes, reptiles, and insects was made by Lieutenant L. H. Marshall, 3d infantry, to whom I am greatly indebted for the unceasing interest he manifested in the success of the expedition, and for his untiring labors in completing a collection which has been pronounced excellent.

This collection was submitted to Professor S. F. Baird, of the Smithsonian Institute, and his preliminary report is attached.

Soils.—I considered it important to collect specimens of soils at all interesting points along the line, and a full collection was therefore made both from the valleys and the table-lands. The plan pursued was to collect at all places where the character of the surface changed, and each specimen collected consisted of three bundles, attached together and labelled: 1st, surface soil; 2d, soil six inches below the surface; and 3d, soil one foot below the surface. In this manner the character and relative value of the soils from all the valleys and table-lands between the Rio Grande and Red rivers were determined.

This collection, with the mineral waters, was placed in the hands of Professor James C. Booth, of Philadelphia, and his report, with the analysis in each case, will be found in the appendix.

A full set of meteorological observations was kept by Dr. Diffenderfer. This table exhibits, for the months of February, March, April, and May, the temperature of the air at sunrise, at 9 o'clock a. m., at 12 m., and at 3 and 9 o'clock p. m., for each day, and, at every camping place, the temperature of the earth three feet beneath the surface; also the direction and character of the winds, the state of the atmosphere, the condition and character of the vegetation, and the temperature and description of the watering-places at each encampment.

I consider these tables eminently useful in exhibiting the climate of the country, and the character and extent of the wood and water along the route.

The diary of the expedition, which is also appended, although it contains much that is irrelevant and uninteresting, will nevertheless serve a useful purpose in filling up details of the features of the country, and the character of the route for each day, and may be of service to such persons as are inclined to pursue this route to the valley of the Rio Grande.

Such have been the persons employed, and, briefly, the instruments used and the methods pursued in determining the data upon which the maps of this survey have been made, and upon which are based the opinions expressed in the report.

As not only the results deduced from these data, but the observations by which the data

themselves were determined, are appended in a tabular form to the report, the value of the opinions, and the accuracy of the results to which they owe their weight, can be at once examined and verified.

There are many other subjects which fell under the observation of the party, and concerning which much information has been collected; but as their importance is remote from the question of the Pacific railroad, I have not thought it advisable to embody them in the report. The object of the expedition was strictly and eminently practical, and the question to be solved had been thoroughly examined for other localities in the United States, and was well understood in all its details; and in conveying information upon such a subject, I have considered it in all respects advisable to avoid embarrassing or encumbering it with any matter not directly pertinent.

With these opinions, the report of this survey has been written, and I only regret that it is not more perfect.

CHAPTER II.

General Description of the Country along the Route.

In glancing at the topographical features of the immense plains which extend westward from the frontiers of Arkansas and Missouri, the first great peculiarity which strikes the attention is the remarkable interruption to their vast monotony presented by the belt of country between the 32d and 34th parallels of latitude. The great deserts, commencing about the meridian of 97°, extend over a distance of six hundred miles, to the eastern base of the Rocky mountains.

In this whole extent they are badly watered by the few sluggish streams which intersect them, many of which disappear altogether in the dry season, and are destitute absolutely of timber, except a sparse growth of dwarf cotton-wood along the streams.

From the northern frontier of the United States, at the parallel of 49°, this immense region of desert country extends without interruption as far to the south as the parallel of 34°. At this parallel its continuity is suddenly and remarkably interrupted.

Between the 32d and 34th parallels of latitude, a broad belt of well-watered, well-timbered country, adapted in a high degree to agricultural purposes, projects for three hundred and twelve miles, like a vast peninsula, into the parched and treeless waste of the plains, and, at its western limit, approaches to within less than three hundred miles of the Rio Grande, at El Paso. The eastern line of this immense region of fertile country is the western limit of the timbered or well-watered country on the north; and this striking peculiarity of the country along the 32d parallel is most specially to be noticed, as a matter of paramount importance in selecting any route for a railroad or wagon road across this continent.

The four great rivers of Texas—the Red river, the Trinity, the Brazos, and the Colorado—taking their rise at the eastern base of the "Staked Plain," intersect this wooded peninsula at nearly equal distances apart; and the Red river having its head of navigation far to the north of it, the other three streams are navigable for steamboats to points not remote from its southern limit.

In selecting any route for emigration, or for the construction of a railroad, and in the establishment of the chain of military posts designed for its protection and for operations against Indians, much time, labor, and expense are avoided, by so locating the route that it shall approach, at as many points as possible, the navigable waters of the streams which drain the country. This subject is so plain and so well understood as to require no detailed explanation, and a glance at the country will suffice to exhibit what facilities of this kind are presented by the route along the northern frontier of Texas.

We find that the navigable waters of the three principal streams of Texas—the Trinity, the Brazos, and the Colorado—approach to within comparatively short distances of the line of the 32d parallel of latitude, and that this parallel intersects the Red river at a point very far below the head of its navigation. The importance of this extremely favorable natural feature of the country cannot be over-estimated.

With this brief reference to the two great peculiarities of the region west of the Mississippi, which are observable at a glance, I will proceed to a general description of the southern portion of New Mexico, and that portion of Texas contiguous to the line of survey, and which properly come within the range of the exploration intrusted to my command.

This description will be as brief as in my judgment is consistent with clearness, and will

only embrace such subjects as have an immediate bearing upon the duties with which I have been charged.

The valley of the Rio Grande, between the parallels of 37° and 32° north latitude, comprises more than nine-tenths of all the settlements of New Mexico, and contains a population of about 50,000 persons. The only other settlements in the Territory, with the exception of three or four small villages west of the river, lie along and very near to the great road from Santa Fé to Independence, and in no case are found further from the valley of the Rio Grande than seventy miles.

That portion of the country which properly comes within the scope of this expedition extends from the parallel of 32° 30′ to the parallel of 31° 30′, and embraces the extreme southern portion of New Mexico, including the Mesilla and Doña Ana valleys, with their villages, and a portion of the county of El Paso, in Texas, including the village of Franklin, opposite the Mexican town of El Paso, and the villages of Isletta and San Elizario, lower down on the river.

The only arable land in this distance of eighty-five miles is that portion of the immediate valley of the Rio Grande which can be irrigated from the river; and, in consequence, the entire population, not probably exceeding eight thousand, is confined within these limits. Considerable crops of grain, principally corn and wheat, are raised; but the wealth of the inhabitants is in their herds of cattle and mules, sheep and goats. The peculiarly favorable character for grazing of the table-lands east and west of the valley of the river, induces, or rather renders necessary, the herding of their stock many miles from the settlements; and to protect these people and their property thus exposed from the Indians who infest the country, the military posts in this section of country have been established.

The Mesilla valley, so called, is about ten miles in length along the west bank of the river, and from two to three miles in breadth to the base of the elevated table-lands which enclose the valley of the Rio Grande. The two villages of Mesilla and San Tomas—the first with a population of about three thousand, the second of about three hundred—are the only villages of the valley. A few detached settlements occur, and would probably swell the entire population of the valley to three thousand five hundred persons.

Doña Ana, opposite the northern extremity of the Mesilla, is the oldest town in this part of the country, having been first settled in 1842. Las Cruces, Las Tortugas, and the military post of Fort Fillmore, are the only settlements between Doña Ana and El Paso, and the population of the valley opposite the Mesilla does not exceed fifteen hundred.

Molino, two miles above, and Franklin, opposite El Paso, are the first settlements which are found south of Fort Fillmore; the ranch of Frontera having been abandoned. With the town of Isletta, twelve miles, and the town of San Elizario, twenty-five miles below Molino, they number about three thousand souls.

The valley of the Rio Grande above Doña Ana, although by far the richest and best timbered portion of New Mexico, has for many years remained uninhabited as far up as the little village of San Antonio—one hundred and fifteen miles—in consequence of its peculiar position, midway between powerful bands of Apache Indians, occupying the mountains east and west, and from obstacles of ground along the river, which have induced all the travel across the famous "Jornada del Muerto," which occupies two-thirds of the entire distance. The great highway from New Mexico to Chihuahua leaves the river where the obstacles to travel along its banks begin to present themselves; and, traversing a high, arid plain—without wood, with little water, and with very indifferent grass—again descends upon the valley, at a distance of about eighty miles; having only effected a gain in distance of about fifteen miles. The military commander of the department of New Mexico has constructed a good road along the banks of the river, and has established a military post (Fort Thorne) in the valley, and opposite the centre of the Jornada; and all government trains and movements of troops are now required to pursue this route. These wise measures will soon put an end to the dangers and privations

of the road across the desert, and will speedily lead to a settlement of the richest portion of the valley of the Rio Grande.

The full advantages of these measures, and the impolicy of undertaking any system of improvements which shall interfere with them, will be fully set forth in a subsequent part of this report.

Of the country between the valleys of the Rio Grande and the Red river.—Of the country between the valley of the Rio Grande at the 32d, and the valley of the Red river at the 34th parallel of latitude, nature has made three great divisions, which present characteristics distinct from each other in every respect.

The first of these divisions embraces the region between the Rio Grande and the Pecos, a distance of one hundred and sixty-nine miles; the second the country occupied by the Llano Estacado, between the valley of the Pecos and the well-watered and fertile lands of Texas, at the headwaters of the Colorado, a distance of one hundred and twenty-five miles; and the third, considerably more extensive than the first two together, extends from the headwaters of the Colorado to the valley of the Red river, at the parallel of 33° 45′.

Of the country between the valleys of the Rio Grande and the Pecos.—The country between the valleys of the Rio Grande and the Pecos consists of elevated table-lands destitute of wood and water, except at particular points, but covered with a luxuriant growth of the richest and most nutritious grasses known to this continent.

This region is intersected by three ranges of mountains, nearly parallel to each other, and having a general direction north and south.

The first of these is the range of the Organ mountains, which, commencing on the east side of the Rio Grande, about one mile north of the town of El Paso, extends to the northward along the east side of the "Jornada del Muerto," until, under other names, it unites with the immense ranges of the Rocky mountains which extend indefinitely to the north.

There are several passes through these mountains from the valley of the Rio Grande, but they are rough and difficult of access from their abrupt inclinations. The approach from the eastward, however, is effected without difficulty, by passing to the south of this range, and intersecting the river about one mile above the town of El Paso. Next in order to the eastward are the Hueco mountains, twenty-four miles from the river. This range extends much farther to the south, but along the present travelled route presents passes easy of access. This ridge unites itself at a short distance above the 32d parallel, with the Sacramento and White mountains, which, continuing to the north, are lost in the main chain of the Rocky mountains. The most easterly range is that of the Guadalupe mountains, one hundred and eight miles from the Rio Grande, and fifty-four miles west of the Pecos. This ridge, although higher and more rugged than either of the others, seems isolated from any connexion with the mountains. It extends with a decreasing altitude, but with more difficult passes, at least forty miles south of the route pursued by the survey, but sinks into the valley of the Pecos about sixty miles north of the 32d parallel. The route through these mountains, although rough in some places for want of work, is of easy passage, and offers grades which, although steep and requiring heavy work, are nevertheless practicable for a railroad. Three hard and elevated table-lands, ascending in order to the eastward, occupy this region, their longest lines being to the southeast, and their greatest width to the northeast, with a very gentle inclination through long distances to the eastward, and an abrupt descent to the westward, their highest lines being in every case very near their western limits. The three ranges of mountains above mentioned occupy the summit-levels of these table-lands, and the highest point of the road between the Rio Grande and the Pecos is the summit of the Guadalupe Pass.

Water is found at intervals, not to exceed twenty-eight miles, between the Rio Grande and the Guadalupe mountains, and from the western base of the mountains to the Pecos abundant springs of water, both fresh and mineral, occur at much shorter intervals.

Timber of large size is only found immediately contiguous to the 32d parallel on the east side

of the Guadalupe range, where abundance of pine of the largest size faces its eastern slope; but fuel of the best quality, and which is alone used on the lower Rio Grande, is furnished by the roots of the mezquite.

The table-lands are covered with the mezquite brush, whose roots are numerous beyond conception, and are of a size varying from one inch to five inches in diameter. As a fuel they are uncommonly fine, and are alone used in the settlements from Doña Ana to San Elizario. As many persons, from ignorance of this fact, have suffered for wood in the midst of this abundance, it is proper to state here that all the table-lands of New Mexico furnish this fuel, and that it can be procured with very little trouble in any part of the country.

The grama-grass, which exists in the most profuse abundance over the entire surface of these table-lands, is nutritious during the whole year, and the plains between the Rio Grande and the Pecos seem intended by nature for the maintenance of countless herds of cattle. Although little protection from Indian depredations has been afforded, and incalculable quantities of stock have been driven off by them, the number appears to be undiminished; and as the original cost is small, and the expense of feeding nothing, cattle and horses are the most abundant possessions of the people of New Mexico.

A good wagon-road, with water at convenient intervals, and offering facilities for travel available at any season of the year, leads from the valley of the Rio Grande at El Paso to the Pecos, near the 32d parallel.

The valley of the Pecos at this parallel of latitude is a level plain of fertile soil, about two miles in width, destitute of timber, and bordered on each side by table-lands about fifty feet high, which descend into it by very gentle inclinations. The river itself is about forty yards wide, and, with a general direction to the southeast, it traverses its valley from side to side in a very tortuous course. Its bed is a compact limestone, over which it descends, with a depth of about two feet, through numberless rapids, and at one point near the mouth of Delaware creek, over a fall of two and a half feet. The valley is very fertile and susceptible of a high state of cultivation, the uniformity of its surface and the peculiar character of the stream affording unlimited facilities for irrigation.

A short distance below the 32d parallel the valley widens to several miles in extent; the rocky bed of the river disappears, and is replaced by falling banks ten feet in height, and by a soft muddy bottom. The few fording-places below the mouth of Delaware creek are very unfavorable at the best season of the year, and during high water are absolutely impracticable. From the accounts of those who have crossed the river by the route from San Antonio to El Paso, and from my own examination of it for one hundred miles below the 32d parallel, it is quite certain that no point below affords anything like the facilities for fording as does the crossing at the mouth of Delaware creek.

Of the Llano Estacado.—Upon the eastern or left bank of the river commences the "Llano Estacado," or Staked Plain, which derives its name from a tradition that, in early times, the Spaniards had staked a road upon it from San Antonio, in Texas, to Santa Fe, in New Mexico. This famous desert, without wood or water, extends from the vicinity of the 30th to about the 35th parallel of latitude, is about one hundred and seventy-five miles across at its point of greatest width, and divides the Rio Grande and its tributaries from the affluents of the Mississippi and the streams of eastern Texas.

From the statements of persons who had crossed it near its northern and southern limits, I was prepared to find it a hard table-land, elevated from six hundred to one thousand feet above the level of the streams which border it on both sides, and faced on the east and west by abrupt rocky precipices. To my surprise, however, the inclination from the Pecos was exceedingly gentle, and the summit-level was attained at a distance of thirty-five miles without an abrupt ascent at any point, and without the appearance of any of the marked characteristics which had been attributed to it. The descent from its summit to the head-waters of the Colorado was so gentle as only to be perceptible to instrumental survey, and there was nothing to mark its

eastern limit except the existence of the tributaries of that stream. Neither bluff nor uncommon swell of ground marks its existence as you approach from the east or west, nor is its uniformity of surface disturbed at any point between the Pecos and the Colorado.

That this singularly favorable combination of circumstances only exists along the line of the 32d parallel is verified by the reports of Captain Marcy, who examined it at the head of Red river, and of Marcy and Simpson, who crossed it on the parallel of 35°, and by my own examination of it to the south. To the north, its eastern side is faced by an abrupt precipice five hundred or six hundred feet high, difficult of approach, and absolutely impracticable of ascent. On the south it is intersected by a range of hills of white drift-sand, absolutely destitute of vegetation, and seventy feet above the general level of the plain.

These hills, over a distance of thirteen miles, present steep ascents, through short distances, in many places; and the loose, movable character of the sand, and its depth, render the passage through it with loaded wagons next to impossible. On approaching from the east or west, these hills bear every appearance of the sand-ridges along the coasts of South Carolina and Florida, and the first hard wind will destroy the traces of the most numerous party. The shifting character of the sand, and its great depth, would render the construction of a railroad through it exceedingly difficult, and it would require constant labor to prevent the road from being buried under the drifting sand.

The Llano Estacado along the line of the 32d parallel (as indeed everywhere else) is destitute of wood and water, except at particular points during the rainy season; but a close examination of its geological features—the detailed results of which will be found in their appropriate place—exhibits the practicability of boring artesian wells at as many points on its surface as would be desirable. The peculiarly favorable character of the ground along the route of the 32d parallel, the directness of this route over it, and the difficulties to the north and south, would seem to present inducements eminently favorable to the construction of these wells. For thirty miles east of the Pecos the surface of the plain is hard, and covered with grama-grass; and from thence to a point about thirty miles west of the head of the Colorado the hard surface alternates with patches of dark red sand, covered with a coarse bunch-grass, about two and a half feet high. Although the sand packs readily into a hard surface, the passage over it for the first time with loaded wagons, and embarrassed by the bunches of high grass, was laborious in the extreme.

The Llano Estacado presents no inducements to cultivation under any circumstances; but with a supply of water at reasonable intervals, it would offer, though in a less degree than the table-lands to the west, facilities for the raising of stock.

Of the country between the Llano Estacado and the valley of the Red river.—The space between the eastern base of the Staked Plain and the Red river, at the parallel of 34°, is occupied by that portion of northern Texas drained by the tributaries of the Colorado, the Brazos, the Trinity, and the Red rivers. With rapidly increasing advantages as you proceed eastward from the Llano Estacado, this region is well timbered, well watered, and possessed of a soil of extreme fertility, capable of sustaining a dense population. The entire country is so gently undulating in its surface, and presents such an abundant and well-distributed supply of wood and water, that it can be traversed in any direction with trains of wagons, and is of so genial a climate that little choice of the seasons is considered desirable in undertaking an expedition through it. A great portion of the timber of the region intersected by the Colorado and its tributaries along this route is the mezquite, which, about thirty feet in height, and from six to ten inches in diameter, divides about equally with the prairie lands this entire district of country. The Brazos and its tributaries are better supplied with oak timber of a larger size; the country is more undulating, and the water more abundant. Immense coal-beds, of good quality, crop out along the valley of the river, and every natural advantage of soil and climate is offered to the emigrant. A military post (Fort Belknap) has been established upon this stream, near the 33d parallel. But by far the richest and most beautiful district of country I

have ever seen, in Texas or elsewhere, is that watered by the Trinity and its tributaries. Occupying east and west a belt of one hundred miles in width, with about equal quantities of prairie and timber, intersected by numerous clear, fresh streams and countless springs, with a gently undulating surface of prairie and oak openings, it presents the most charming views, as of a country in the highest state of cultivation, and you are startled at the summit of each swell of the prairie with a prospect of groves, parks, and forests, with intervening plains of luxuriant grass, over which the eye in vain wanders in search of the white village or the stately house, which seem alone wanting to the scene.

The delusion was so perfect, and the recurrence of these charming views so constant, that every swell of the ground elicited from the party renewed expressions of surprise and admiration.

It may seem strange that a region suggestive of such florid description should still remain so nearly uninhabited; but it must be remembered that this part of Texas is yet but partially explored, that it is far from the markets, and that it is still infested by bands of hostile Indians. A full knowledge of its startling beauty, and of its amazing fertility, and the construction of facilities of communication with a market, will soon convert this charming region into a reality, of which nature has exhibited so beautiful a presentment.

Over a very gentle dividing ridge we descended upon the tributaries of the Red river, and a great increase in quantity and size of timber was immediately apparent. At least four-fifths of the country drained by the tributaries of Red river is covered with timber of a size and quality to be favorably compared with any timbered region on this continent.

The immediate valley of Red river is from two to five miles in width, without prairie in its whole extent in the neighborhood of Preston, covered with large timber of every description, and possessed of a soil of amazing fertility. At some points the surface is covered with a white or red sand, about three inches in depth, below which is a fat, dark, vegetable mould, from three to six feet thick, and of the most astonishing richness.

The valley is being rapidly settled by cotton-planters from Tennessee and Mississippi; and although the immediate bottom-lands along the river are exceedingly difficult of settlement and culture, from the immense size and quantity of the timber, they are nevertheless preferred to the prairie lands in the vicinity, in consequence of the exceeding fertility of the soil. The river, at the 34th parallel, is about eight hundred yards wide, and is susceptible of steamboat navigation for five or six months of the year.

Proceeding from this point to the eastward, over a country well watered, well timbered, and of great fertility, and inhabited by whites and partially civilized Indians, who cultivate the soil, we reach, at a distance of one hundred and fifty miles, the western frontier of Arkansas.

Of the seven hundred and eighty miles of distance from the western line of Arkansas to the valley of the Rio Grande, at El Paso, nearly five hundred miles traverse a fertile, well-watered, and abundantly timbered region; and of the remaining two hundred and eighty, one hundred and sixty are through a country which, although of little agricultural value, except in the immediate valley of the Pecos, is nevertheless admirably adapted to the raising of stock, and offers every desirable facility for travel, at any season of the year.

There is but one military post (Fort Belknap, on the Brazos) along the immediate line of this route—the chain of frontier posts in Texas gradually departing from it to the south. In the southern part of New Mexico there is no post east of the valley of the Rio Grande; and the distance between the nearest posts in Texas and New Mexico is five hundred and eleven miles.

A brief review of these remarks exhibits the fact that by procuring water on the Staked Plain, a route for emigration or for military purposes is presented, from the frontiers of Arkansas to the valley of the Rio Grande, which, for more than half the entire distance, traverses a region fertile, well watered, well timbered, and of mild climate.

The vast importance of such a route, and one which can be thus protected, cannot too forcibly

be dwelt upon, when the dreadful sufferings and hardships experienced by the immense emigration to California since 1849 are duly considered. The establishment of such a route will put an end forever to dangers and privations which have proved fatal to so many of our citizens, and will not only facilitate our military operations in the Indian country, but will open to settlement and cultivation a region eminently adapted to agricultural purposes.

To exhibit briefly the character of the country along the immediate line of survey, I append a few extracts from the note-books of the expedition.

EXTRACTS.

February 21.—Hueco Tanks. Rain-water in natural tanks; wood and grass. From El Paso to Hueco Tanks, country has a very gentle slope; is covered with fine grama-grass, and has a sandy soil.

February 22.—Cerro Alto. No water; brush for wood; good grass. North and west of the cañon of the Cerro Alto, a range of hills with sloping sides. Road to-day rocky.

February 23.—Sierra de los Alamos. Springs on the side of the mountain; good grass; cacti for wood; country gently undulating; road good.

February 24.—Los Cornudos. Water in natural tanks; wood and grass; country rolling; road rocky in places.

February 25.—No water; cacti for wood; fine grass; country level; road good.

February 26.—Ojo del Cuerbo. Fine springs—water slightly sulphureous; small brush for wood; poor grass; country gently rolling; road generally good; rocky in places. Ground near the salt lakes covered with a white efflorescence of salt.

February 27.—West face of Guadalupe mountains. No water; cacti for wood; fine grama-grass; country ascending; road not very good; some sand.

February 28.—Head of cañon in the Guadalupe Pass. Springs; grass and wood not very good; road rocky and bad.

March 1.—Pinery on the east slope of the Guadalupe mountains. Water, wood, and grass in the greatest abundance. Fine pine forests on the mountain-sides; road not very good; rocky in places.

March 2.—Independence Spring. Fine springs; thickets of scrub-oak, and good grass; road gravelly and good; country with a gently descending slope.

March 3.—Head of Delaware creek. Several mineral springs, and one remarkably fine one of fresh water; dwarf cedar in the vicinity; good grass; country rolling; road rocky in places.

March 6 and 7.—On Delaware creek. Water, wood, and grass; country undulating; road good.

March 8.—On the Pecos, at the mouth of Delaware creek. Water, (slightly brackish;) fine grass; roots of mezquite for wood; road good.

April 8.—On the Llano Estacado. No water; fine grass; brush and roots for wood; country ascending and undulating; road, for a few miles, rocky; the remainder of it good and firm; from the Pecos to this camp, country covered with fine grama-grass.

April 9.—On Llano Estacado. No water; grass not very good; roots and brush for wood; country undulating; sandy for a portion of the distance; grass not very good in the sand, but good elsewhere; abundance of game where the grass is good; saw chain of white sand-hills towards the south, about thirty miles off.

April 10.—On Llano Estacado. No water; good grass; roots for wood; country gently undulating and sandy. In the sand the grass was a coarse red bunch-grass, about two feet and a half high. Range of white sand-hills towards the south, in sight all day.

April 11.—Sulphur springs of the Colorado. Water and grass good; roots in abundance in the vicinity, for wood; country nearly level; road hard and good; fine grass all day; game and mustangs seen all day.

April 12 and 13.—On the open plain. No water; wood and grass; country rolling, and dotted with groves of mezquite; covered with grama-grass, and intersected with numerous small streams—tributaries of the Colorado.

April 14.—Colorado river. Water, wood, and grass. The Colorado at this point is a running stream—water of a reddish color; steep red-clay banks, and about fifteen feet wide; country undulating; rocky in places; near here there are many detached mounds of red-stone.

April 15, 16, 17, 18, and 19.—Country gently undulating; large forests of mezquite; every few miles small streams of water—tributaries of the Clear and Double Mountain forks of the Brazos; fine grass everywhere; road good.

April 20.—On a large creek. Water, wood, and grass abundant; country undulating, with groves of mezquite scattered over it; on this creek large elm trees; good road.

April 21, 22, 23, and 24.—On Clear fork of Brazos. Water, wood, and grass good. Clear fork is a running stream, of about twenty yards in width, and has a narrow valley heavily timbered with pecan, elm, and other trees; country rolling and rocky; few trees, except on the Clear fork; road not good.

April 25 and 26.—From the Clear fork of the Brazos to the Brazos. Country rolling, mostly covered with trees; oak of several varieties, mezquite, and other trees; numerous small streams; good grass; good road. The Brazos at this point is about ten inches deep in the channel; water brackish.

From *April* 26 to *May* 16.—Country between the Brazos and Preston, on Red river, is gently undulating; contains a rather larger proportion of timber than prairie, and is intersected with numerous clear running streams of fresh water, which descend into the Brazos and Trinity on the south, and the Red river on the north. Fine grass and good camping places everywhere; road good.

CHAPTER III.

Of the Indian Tribes.

The Apaches.—This is by far the most numerous tribe of Indians in New Mexico, and extends along both sides of the Rio Grande, from the southern limits of the Navajo country at the parallel of 34°, to the extreme southern line of the Territory, and from thence over the States of Chihuahua, Sonora, and Durango, of Mexico. Their range eastward is as far as the valley of the Pecos, and they are found as far to the west as the Pimos villages on the Gila. They are divided into numerous bands, each of which takes its name from the district of country in which it is most frequently found, and all of which are under the control of separate and independent chiefs. They are greatly the most difficult to control of the Indians of New Mexico, as they not only infest the entire southern portion of the Territory, but carry their plundering forays as far south as the city of Durango itself. The valley of the Rio Grande below the parallel of 33° 30′ is midway between the haunts of the White Mountain or Mezcalero and Copper Mine or Gila Apaches; and in consequence, along the valley of the river, and along the route over the Jornada del Muerto, most of their depredations have been committed. They lie in wait along that portion of the route remote from settlements, for small parties and unprotected trains; and having plundered both the men and the wagons, they retreat rapidly to the fastnesses of the mountains east and west of the river. Their country is nearly destitute of game—is little adapted to cultivation, even were the Indians disposed to till the soil, and no treaties nor inducements can for any length of time restrain their plundering expeditions into the settlements of New Mexico. These Indians are wholly different in their characteristics from any with whom we have been brought into contact in the valleys of the Mississippi or Missouri. They are much less intelligent and less bold than, and have none of the warlike tastes or accomplishments of the Pawnee or the Sioux. Their sole object is plunder, and they are totally destitute of the ambition or the courage to distinguish themselves by warlike achievements. The principal aims of their greatest war expeditions have been directed to the plundering of small ranchos, and the driving off of herds of stock, and the murder of a miserable and helpless shepherd is matter of immense exultation.

They carry off the children from these ravaged settlements, and either adopt them into the tribe or make slaves of them.

In this habit they are closely imitated, or have been set the example, by the people of New Mexico, and it is very doubtful whether a settlement can be found in the valley of the Rio Grande not possessed of Indian slaves. These poor creatures are bought and sold like horses or mules, and it seems rather too much to expect that the Indians shall deliver up the Mexican prisoners in their possession to the authorities which countenance openly the sale and slavery of numbers of their tribe. So far as three years' experience in the country has enabled me to judge, it has seemed to me that the amount of robbery is about equal between the lower classes of New Mexicans and the Indians, whose herds of stock are frequently together, and that protection from plunder, which we are expending so much money to secure the former, could with equal justice be extended to the Indian.

It is difficult to say upon which side plundering predominates, although all depredations committed by the Indians, tenfold exaggerated, are duly laid before the authorities.

Those tribes of Apaches which I have named, occupying the fastnesses of the mountains east and west, descend upon the valley of the Rio Grande as far to the north as the town of Socorro,

and as far to the south as the San Elizario of Texas. They drive off great quantities of stock, and make good their retreat to the mountains, before intelligence of their presence can be communicated to the commanders of the military posts along the river. They have absolutely no object but plunder, or perhaps the desire to recover their own, and have never, to my knowledge, been known to attack a larger number of persons than ten. The great difficulty of controlling or chastising them has consisted in the impossibility of overtaking or bringing them to an engagement. Upon the approach of a body of armed men, they scatter to all points of the compass, over the mountains and by-paths of the country, and only reunite at some point far removed from danger. On their wiry and active ponies they scale heights apparently impracticable, and rush at headlong speed through the most difficult and dangerous passes of the mountains.

A company of seventy-five men can traverse their country in any direction without encountering danger or resistance. Against such Indians as these it is plain that military expeditions cannot succeed, and instead of endeavoring to *punish*, it would seem wiser to take measures to *prevent* their depredations.

The changes in the present military arrangements which seem to me desirable for this object, will be duly suggested. Efforts have been made to induce these Indians to settle in the vicinity of the posts, and to cultivate fields, but so far without hope of success.

It is almost impossible to arrive at any correct notion of their number; but from all I could learn, they cannot exceed seven thousand persons.

The Lipans.—Of these Indians I know but little. Their range is far to the south of the 32d parallel; and although small parties have been occasionally seen in the valley of the Pecos and near to the Guadalupe mountains, their visits have been so rare and seemingly so objectless as to render it but little important that they should be enumerated among the tribes of Indians who infest this region of country. They number, probably, five hundred souls.

The Camanches.—The Camanches—the Arabs of the deserts of North America—have long occupied an important place among the Indian nations of this continent. In conjunction with the Sioux or Dacotahs of the North, they have for many years maintained an almost undisputed sway over the immense regions between the Rocky mountains and the frontiers of the western States. They are variously estimated at from 15,000 to 40,000 persons; but probably one-half of the larger estimate will fully include their entire population. Many small tribes under different names, but speaking the same language, and fragments of bands whose power and influence have long since passed away, live among them in friendly or dependent relations. In their hunting expeditions among the buffalo, they roam as far to the north as the 38th parallel of latitude; and, passing the Rio Grande five hundred miles from their homes, they invade the dominions of Mexico to within two hundred and fifty miles of her capital. In small parties, and unsupported, they penetrate into the densest settlements of the northern States of Mexico; and in broad daylight, and nearly unopposed, they carry off into captivity hundreds of human beings, and thousands of horses and mules, and lay under contribution populous towns, and even large cities. They are objects of the extremest terror to the Mexican; and it is related that a single Camanche, even at mid-day, dashed at speed into the public square of the city of Durango, and by his mere presence caused the hasty closing of the stores and public places of the city, and the rapid retreat of a population of thirty thousand souls to their barred houses. He remained an hour roaming through the deserted streets, and was only captured by being lassoed from the window of a house as he was riding triumphantly but carelessly from the suburbs. Such an occurrence must appear amazing to the last degree to an American, who has been accustomed to deal with the Indian upon terms of advantage; but in the Mexican, the sight of a half-naked Camanche, with his shaggy horse and his quiver of arrows, produces a paralysis of fear, from which he seems never to recover. These wretched people, shut up in their barred and grated villages, will look forth despairingly, but without even an inclination to resist, upon one-third of their number of half-armed Camanches, rav-

aging the fields and haciendas under their very eyes, and carrying off into hopeless captivity the miserable women and children who have not succeeded in making good their escape. Under the uncontrollable influence of this singular and despicable apprehension, it does not seem strange that they should have attached so much value to our protection from these Indians, nor that they should have insisted with so much earnestness upon inserting such a provision into the treaty of Guadalupe Hidalgo. The women who are thus carried off from their homes become the wives or servants of their captors; and the men, after a probation more or less lengthy, are adopted into the tribe, most generally in a dependent condition.

Of the many I have seen thus held in captivity, I have never yet met one who was willing to return to his home or his country. In the women this feeling is not difficult to understand. They have all been subjected to the inhuman but invariable outrages which are perpetrated by Indians upon their female prisoners at the moment of capture; and they afterwards most probably form attachments to the warriors who have taken them to wife, and by whom they have borne children, who enjoy every privilege of the most favored of the tribe. In the men the feeling is more difficult to comprehend. Their cowed and sullen look, and shuffling, timid manner, sufficiently betray the position they occupy; and their avowed reluctance to return to their homes is probably due to a fear of the punishment which the expression of such a wish would be certain to bring upon them.

It would be tedious and out of place, in a report which has in view merely the military precautions proper to be observed in reference to them, to enter into a detailed description of the character and manners and customs of these Indians; and my remarks concerning them will probably be more brief than so prolific a subject would seem to justify. The description of the route of this expedition has a direct bearing, however, upon this entire tribe of Indians, as their nomadic and restless habits induce them to roam continually through the immense region over which they claim control.

The Camanches are small of stature; quick and sprightly in appearance and action; and in all cases, where I have seen them, they wear moustaches and heads of long hair instead of shaving to the scalp-lock, as is the custom with the more northern races. Although sufficiently courteous in their communications with the whites, they nevertheless exhibit a half-defiant, half-scornful air, as if their friendly expressions were more the result of convenience than of necessity. Over the subordinate bands of Indians who live among them they invariably maintain an undisputed supremacy, neither consulting them nor allowing from them an expression of opinion upon any matter which they have under consideration. During the summer months nearly the whole tribe migrates to the north, to hunt buffalo and wild horses on the plains of the upper Arkansas, but return in the autumn with the proceeds of their hunting expeditions to pass the winter in the timbered country along the valleys of the upper Colorado, Brazos, and Red rivers. Since the establishment of military posts on the frontiers of Texas, and the consequent advance of settlements into their country, the Camanches have been brought into much more constant and familiar intercourse with the whites, and have begun to contract that passion for ardent spirits which has proved so fatal to their race. The stringent laws of the United States have prevented, as far as it has been possible, the introduction of spirituous liquors into the Indian countries in the territories over which the general government has control; but the State of Texas recognises no Indian title to lands within her borders, and no laws interdict the traffic of ardent spirits, which present an attraction entirely irresistible to the Indian.

To this fatal policy, or rather want of policy, on the part of the State, many of the late Indian difficulties in Texas undoubtedly owe their origin; and until some district of country is set apart for the Indian tribes, governed by the same strict laws in reference to intercourse with them which now prevail in the Territories of the United States, constant and harassing troubles with the Indians will continue to mark the history of Texas.

Up to the period of the occupation of the country by the troops of the general government, the Camanches were accustomed to equip large expeditions, which, traversing the State of

Texas by various routes, and passing the Rio Grande at numerous points in its course, even as low down as Matamoros, laid waste the northern States of Mexico. The establishment of a chain of military posts enclosing the extreme settlements has seriously interrupted their hitherto unmolested progress to the Rio Grande, and they have been compelled to conduct their marauding parties to the frontiers of Mexico by routes much farther to the west. The broad trail, which seems now in most constant use, crosses the Pecos at the Horse-head crossing, and, skirting the eastern base of the Llano Estacado along the line of the extreme western watering-places, conducts to the valleys of the upper Brazos and Red rivers, and to the plains of the upper Arkansas, by a route which at no point approaches to within two hundred miles of a military post.

The good effect of the chain of military posts in Texas has been thus far exhibited, and it would seem the part of wisdom to continue such a line as nearly as possible to the valley of the Rio Grande. The present military stations, although continued in a southerly direction to the river, leave a district of country unoccupied, at least five hundred miles in breadth, between El Paso and the nearest post in Texas.

This distance is by far too great to insure any efficient moral effect upon the Indians, whose marauding parties now pursue a route traversing this unoccupied region; and it would seem that the continuation of the chain of military posts by the most practicable route to the Rio Grande should be an object for early consideration. At the headwaters of the Colorado, and on the broad trail along the eastern base of the Staked Plain, to which I have referred, we came upon an encampment of about fifty Kiowa Indians, returning from a plundering incursion into Mexico, with at least a thousand horses. They did not seem to relish our approach—in the fear, probably, that we would relieve them of part of their plunder; and immediately after we came in sight, they hastily collected their baggage and animals, and took the trail to the north, firing the prairies as they went off.

Heavy clouds of smoke during the day, and a lurid glow in the western sky at night, exhibited to us, for several days, the progress of the fire towards the valley of the Pecos. The only Indian who approached us evidently did so to reconnoitre, and was exceedingly anxious to know whether we had seen any Camanches, of whose vicinity he seemed to entertain a good deal of anxiety. Although the Kiowas live with the Camanches upon friendly terms, it was plain that this party was fearful of being compelled at least to disgorge a portion of their plunder, in the way of tribute to their more powerful friends.

The range of the Camanche Indians extends over the plains of the Arkansas from the vicinity of Bent's fort, at the parallel of 38°, to the Gulf of Mexico, and they occupy the country along the route of this expedition from the eastern base of the Llano Estacado to about the meridian of longitude 98th.

The Kiowas.—Of the many small bands and fragments of tribes which are found living with the Camanches, by far the most powerful are the Kiowas, who probably do not number more than fifteen hundred. Although similar in appearance, and almost identical in manners and customs, with the Camanches, they are, doubtless, from their equivocal position, much more deceitful and unreliable in their professions, and are absolutely destitute of most of the chivalric characteristics which distinguish the Camanche brave.

They hunt the buffalo in company, and parties of the Kiowas always accompany the plundering expeditions of the Camanches into the States of Mexico. They are divided into several subtribes, under the control of independent chiefs, and portions of them, even during the winter months, occupy the valley of the upper Arkansas, and of its tributary, the Purgatory river. The "Big Timbers" of the Arkansas, and the bushy shores of the Purgatory, afford them fuel and shelter from the storms, and they find an abundant supply of food in the immense herds of buffalo which pass the winter along the banks of the Arkansas. In common with all the Indians of the plains, they maintain a continual warfare with the Indians of the mountains; and the Utah Indians, who inhabit the fastnesses of the Raton and Sangre de Cristo,

frequently avail themselves of the absence of the Camanches, during the summer, to make descents from the mountains upon the small parties of Kiowas who remain in the valley of the Arkansas.

The surplus horses and mules which are brought from Mexico are traded among the Arapahoes and Cheyennes, and with these Indians they maintain a kind of equivocal peace, which is solely dependent upon the success of their plundering expeditions in the south.

A small fragment of what are known as the Apaches of the Plains also live among the Camanches, but are so few in number, and of so little influence, as to require but a bare mention in this paper.

The Tonkawas, Wacos, Wichitas, Caddoes, &c.—The valley of the Brazos, and the country from thence to the Red river, along the route, are occupied by the several small tribes of Indians above mentioned, probably not numbering in all one thousand persons. They are peaceable and friendly, and for several years past have committed no depredations.

In most cases they cultivate small farms, and are dependent fo. subsistence upon agricultural products rather than the spoils of war or the chase. They are easily held in control by the military post (Fort Belknap) established upon the Brazos.

The country between the Red river and the western frontier of Arkansas (one hundred and fifty miles) is occupied by the semi-civilized tribes of Choctaws, Chickasaws, and Cherokees, who, several years since, were emigrated to their present homes from Georgia, Alabama, and Mississippi. They occupy houses, cultivate fields, and approach nearly, in the matter of costume and manners, to the whites who live among them. They are fond of drinking and gambling, and although occasional fatal quarrels occur with each other, they are in other respects harmless.

It will be observed that in this brief account of the Indian tribes which are found along this route, I have confined myself to a mere statement of their estimated numbers and the districts of country which they occupy.

My instructions required me to report upon the military features of the route, and in this respect such information concerning the Indians was necessary to explain fully the military dispositions which, in my judgment, will be advisable to insure security to the emigrant and the settler.

I have therefore supposed, that however interesting to those curious in such matters might be a detailed account of their manners and customs, their appearance and costume, a vocabulary of their languages and wild and irreconcilable traditions concerning their origin and history, such things could have little practical bearing upon the duties with which I was charged, and would, therefore, be little appropriate to this report.

CHAPTER IV.

Military Character of the Route.

From the period of the establishment of this government, the policy to be observed in respect to the Indian tribes within our borders, and the selection of sites for the military posts designed to secure the objects of this policy, have been questions surrounded by difficulties.

Kind treatment, the payment of annuities which enable the Indian to live without resort to plunder, and the maintenance of friendly and peaceful relations—which now seem the fixed policy of the government—have to some extent simplified the question of military positions, although neither the prosperity of the Indian nor the security of the white man seems to have been greatly promoted.

So long as the Indians to be controlled occupied the fertile valleys of the Mississippi and its tributaries, a glance at the map exhibiting the districts of country occupied by the various tribes was sufficient to determine the positions of the military posts designed for their control. The entire region then occupied by the Indians over whom we claimed jurisdiction was so amazingly fertile, and of such vast natural advantages, that the military posts which insured even partial security became at once *nuclei* for settlements, which increased in number and prosperity with such surprising rapidity, and so soon superseded the necessity of military protection, that the posts themselves became almost encampments of troops, whose movement to the westward was, although gradual, uninterrupted. The incorporation of New Mexico and California, the occupation of Utah and Oregon, and the acquisition of the immense deserts which separate them from the valley of the Mississippi, have surrounded this question with difficulties which, up to this time, have not been entirely overcome.

The necessity of occupying, with the small force at our command, an immense region of country doomed by nature to perpetual sterility, possessing not one requisite for the support of a military post, and far from points where even the necessaries of life can be procured, yet traversed by several great highways of travel and emigration to our possessions in New Mexico and on the Pacific, and infested by bands of hostile Indians whose number is yet unknown to us, has brought other and new elements into the consideration of our military arrangements.

Every day renders more manifest the necessity of providing more ample means of accommodation and protection to the immense rush of emigration from the valley of the Mississippi to the Pacific ocean; and a consideration of this subject would seem to point to the establishment of some one great highway for this purpose, which should be common to all the emigrants.

With the small force of our regular army, and in view of the immense difficulty and enormous expense of supplying or maintaining a chain of military posts across the plains, it would be clearly impossible to occupy or render secure more than one such line; and the selection of a route affording as many facilities as possible for travel, and for the supply of the posts, would seem to be a matter of primary consequence.

While our possessions were confined to the fertile and comparatively limited region along the valleys of the Mississippi and its tributaries, the establishment of routes for emigration was a matter requiring little consideration; but occupying, as we now do, the immense deserts which extend from the frontiers of the western States to the Rocky mountains—over which thousands of emigrants are constantly pushing forward to the Pacific, who require protection in a country in which it is next to impossible to establish military posts—the determination of a route which

should accommodate their necessities and insure their safety should be a matter for careful examination.

The immense ranges of the Rocky mountains, and the vast deserts to the eastward, extending in uninterrupted barrenness to the frontiers of the western States, are but partially explored, and the Indian tribes which roam through them almost unknown. The military posts which have been established seem to have been mere experiments, which, judging from daily accounts of the sufferings of the emigrants, and the repeated and fatal attacks of the Indians, appear to have been attended with but partial success.

A brief statement of the important requisites to be considered in the establishment of military posts in the Indian country, and in the selection of a great route to the Pacific for emigration and for military purposes, seems to me necessary to the explanation of the suggestions which I shall offer in reference to the establishment of military posts along the route, the exploration of which has been intrusted to me.

Of the establishment of military posts in the Indian country.—There are several elements which enter into the selection of a site for a military post among Indians: first, that it should be so placed as to exercise the greatest amount of control over the Indians; second, that it shall be easy of access from its depots of supplies and military stores; and, third, that it shall, if possible, in view of these primary objects, be situated in a country adapted to settlement and cultivation. To locate a post advisedly, therefore, a knowledge of the number, character, and habits of the Indians, and of the districts where they most commonly live, and full information of the agricultural and topographical features of the country, are important requisites.

Indian depredations are never committed in the vicinity of their homes, or the places where they leave the women and children during expeditions for plunder. They organize parties far from the points at which they design to commence their forays, and return, after months of danger and hardship, to enjoy the spoils of their expeditions. A post in the immediate vicinity of where they are in the habit of wintering, and of leaving their women and children during these expeditions for plunder, would undoubtedly, in a great measure, restrain their incursions far into the interior, since they fully understand that their outrages in the settlements would be visited with equal severity upon those who were left behind defenceless.

A military post established with this view would be infinitely more conducive to the security of the settlements in its rear than half a dozen posts within the settlements themselves.

The principal object of a military post in the Indian country is undoubtedly to restrain depredations by a display of military force; but many results of equal or even greater importance are the consequence of its establishment. The Indians are brought into familiar contact with the whites, and an acquaintance springs up from which naturally results a traffic of commodities which is mutually advantageous. The Indian begins to indulge in luxuries unknown to him before, and which he afterwards relinquishes with great reluctance. The supplies of presents, provisions, &c., which are provided by the government, enable him to indulge in these luxuries, and in an idleness very attractive to him, and obviate entirely the necessities, hunger and nakedness, which have prompted his expeditions for plunder.

With all these advantages to himself which result from the establishment of a post and the payment of reasonable annuities, which enable him to live without work, and with the certainty that his women and children are constantly in the power of the troops, it seems nearly incredible that he should undertake expeditions for plunder, the very success of which would jeopard, with such extreme probability of destruction, his wife and family and possessions, and would certainly deprive him of the power of indulging his indolence, and cut him off from the use of luxuries which have become necessary.

There is no doubt but that judicious management at a military post in the Indian country will completely effect these results. It would be well also for the mounted troops to be kept moving about in the country during the season for field service, keeping as nearly as desirable in the vicinity of the Indians, and in fact, to some extent, conforming during the summer to

their wandering habits. The moral effect of the troops would thus be continually felt, and the Indians would be forced to keep their warriors constantly on hand to defend them from attacks which might at any time be made upon them.

Another well known effect of military posts heretofore has been to attract settlers, who cultivate the country in the vicinity, and who are able in a short time to supply most of the necessities of the garrisons. A very few years (as experience has already sufficiently demonstrated) find these settlements so prosperous and with so large a population that military protection is no longer required, and the garrisons can safely be moved farther into the Indian country, to produce in time the same results.

The settlements not only commence in the immediate vicinity of the posts themselves, but gradually creep along the routes from their depots of supplies, and the whole region between the line of extreme settlements and the chain of posts would soon be occupied by the hardy pioneers of western settlement. The Indians would, as has heretofore been the case, retire before them, and would, after the lapse of a very few years, find themselves beyond the line of posts. By this process our western States have been settled, and hence the very great importance of establishing military posts, where it can be done with a view to military considerations, in a fertile, well-watered region, adapted to settlement and cultivation. There are few places to which the Indians of the plains can retire for protection against the hardships and sufferings of a winter on the prairies, and the policy of occupying these positions with military posts is sufficiently apparent. A state of war, or the commission of depredations, which almost always occur in the winter months, when the difficulty of procuring supplies of food and clothing is greatest, would effectually debar them from access to the shelter of the timbered region and deprive them of the assistance of the government; and it seems clear that a powerful influence would be thus brought to bear in restraining their depredations.

In the establishment of a chain of military posts for combined action, a view must be had also to the advantage of so locating the line of posts that it shall divide the tribes upon which it is intended to operate, and thus prevent any combined action. The reluctance with which wild Indians cross a well-beaten road for the purpose of committing depredations is well known to all conversant with their habits, and the establishment of well-beaten routes to connect the posts along the line is a matter of the first consequence. It enables the garrisons to concentrate promptly should the necessity ever arise; and being constantly traversed by troops, it absolutely cuts off any party of Indians which has crossed it on plundering expeditions. This route should be plain and well-beaten, and constantly traversed between the posts by an armed force. The posts should be placed along it at intervals, certainly not to exceed one hundred and seventy-five miles if it be possible to avoid it. With such a chain of posts through the centre of the Indian country, the greatest moral effect is produced; the safety of the route between the posts is secured, and the Indian tribes are divided from any combined action against the settlements. The chain of military posts along the frontier of Texas has already exhibited the beginning of these results. The Camanches, who have been in the habit heretofore of traversing the State by various routes to the Rio Grande, are now confined to one which carefully avoids crossing or approaching the chain of posts: their depredations have been of much less extent or consequence; and wherever the posts have been placed in a country adapted to agriculture, settlements have been commenced. The Indians are beginning to frequent the posts for trade, and are gradually assuming the dependent condition which I have stated above to be the inevitable result of association with the whites and indulgence in their luxuries.

When people of such different races and of such diverse interests are brought into contact, difficulties must be anticipated; but the military arrangements I have suggested would effectually destroy the possibility of general warfare, or combined or powerful expeditions for plunder.

Such are some of the important elements which enter into the selection of sites for military posts in the Indian country, and such are a few of the results which they produce. The establishment of a line of posts across the plains would necessarily determine the travelled routes

across this continent, and I have therefore considered it proper to enter fully into the subject, that the facilities for this purpose, presented by the route I have explored, may be fully estimated.

Of the selection of a route across the plains.—So long as the transportation to California by sea continues to be so difficult and expensive, and the value of stock of all kinds in that State so great, a vast excess of emigration, which is in a great measure confined to persons whose means are limited, must pursue the overland routes. The emigrants expect and are entitled to protection by the government, and the consideration of the measures to effect this object has become of vast importance.

The almost insuperable difficulties which surround the establishment of a line of military posts on the plains, which are exposed, without fuel or the means of constructing shelters, to all the rigors of the seasons, and far from points where even the necessaries of life are to be procured, forced to occupy a region possessing neither agriculture nor mineral resources, and doomed by nature to perpetual solitude, would seem to render it a matter of the extremest importance to shorten such a line as much as possible, and with that view to select a route which should cross these deserts at their narrowest point.

A consideration of secondary, but still of great consequence, would point to the location of the route through a region in which the extremes of heat and cold are least known, and in which unexpected difficulties or unavoidable delays would not subject the emigrant to extreme sufferings from cold and hunger, which have proved fatal in so many instances.

In a military point of view this would seem nearly of equal importance. Although the departure and movement of military expeditions across the plains can be arranged with a foresight which will secure them against the probability of such exposure, yet, as a question of expediency, it would be far wiser to select a military route which can be traversed without difficulty at any season of the year.

A very hasty examination of the country exhibits the fact that the vast deserts between the valley of the Rio Grande and the frontiers of the western States contract to their least width along the belt of country between the 32d and 34th parallels of latitude. The average distance of six hundred and fifty miles over these vast deserts is here reduced to less than three hundred miles, and along a route where the extremes of heat and cold are absolutely unknown.

For three hundred and eleven miles west of the *eastern* line of the prairies, the belt of country along the 33d parallel presents absolutely a combination of all the favorable circumstances which I have suggested as necessary to the establishment of a chain of military posts. The line of posts along the route traverses the heart of the country occupied by the most powerful tribe of Indians west of the Mississippi; intersects the wooded districts in which they are forced to seek shelter from the horrors of a winter on the prairies; separates the Indians of Texas from those of the northern plains; presents numerous points, offering every facility of wood, water, and grass, for the establishment of a military post; crosses the principal rivers of Texas at no great distance from the heads of their navigation, at which can be established depots of supplies; traverses a region of fertile soil and abundant timber, affording every advantage to the settler, and of mild and genial temperature at every season of the year; and, finally, avoids more than one-half the desert country between the Rocky mountains and the valley of the Mississippi. It commences on the Red river at a point navigable by steamboats, and connects by a good road, constantly travelled, with the Arkansas river below the head of its navigation.

The only obstacle on this route, and one which alone has prevented it from becoming the great and only highway across the plains, is the want of water on the Llano Estacado, over a distance of one hundred and twenty-five miles; but this difficulty, as will be exhibited hereafter, may be obviated so easily, and at so little expense, that it cannot weigh as a feather in the balance against the unrivalled advantages of this route.

Of the three hundred miles of desert along the route, nearly two hundred are through a region affording water in abundance and fuel entirely sufficient for camping purposes; and the

whole distance of three hundred miles is occupied by a country profusely overgrown with the mezquite and grama grasses—by far the best and most nutritious grasses on this continent.

It is quite unnecessary to dwell upon the importance of the remarkable advantages peculiar to this route, and I therefore proceed, with these opinions, to suggest the military arrangements which seem to me most judicious.

Of the present military posts, and proposed changes.—The military posts which now enclose the settlements of Texas, considering the very large intervals between them, and the weakness of their garrisons, have been attended with wonderful success, although not situated, as, in my judgment, they should be, with a view to combined action with the military arrangements in New Mexico. The chain of posts in Texas is separated from the line of posts in New Mexico along the valley of the Rio Grande by a distance of nearly five hundred miles; and this great space, by far too extensive to be rendered secure by the present military arrangements, is traversed only once or twice during the year by the trains of supplies and military stores for the posts on the Rio Grande.

Any protection other than from their own combinations is, therefore, only afforded to the emigrants and to the immense trains of the traders in New Mexico, Chihuahua, and Sonora, at long intervals; and the almost daily accounts of loss of life by sufferings, and from the attacks of Indians, are due to the defective disposition of the troops.

The post (Fort Belknap) which has been placed on the upper Brazos, near the 33d parallel, is in all respects well situated upon the line which I have suggested, and is garrisoned by two companies of the 7th infantry and one company of the 2d dragoons.

Mounted troops are far more efficient than infantry at frontier posts; and I would therefore suggest the propriety of replacing one of the infantry companies by a company of mounted men. This post is about one hundred and seventy-five miles from Fort Washita, and a somewhat less distance from Fort Arbuckle, on the verge of the Chickasaw and Choctaw country, and settlements have gradually advanced towards it to a distance of fifty miles from the valley of the Red river, at a little village of Preston. Settlements have been commenced in the vicinity of the post, and also at a distance of thirty-five miles to the west, and in a few years the wants of the garrison will be readily supplied by them.

The Indians of the small friendly tribes I have mentioned have also established their villages in the neighborhood.

For all the military purposes required, this post is admirably placed, and is only defective, as I have stated above, in its garrison.

About one hundred and thirty-five miles to the southwest we find Fort Chadbourne, on a small tributary of the Colorado, and about twelve miles from the river.

In view of the reasons I have suggested, this post is out of position, and I therefore recommend that it be thrown forward in a northwest direction, to the intersection of the line from Fort Belknap to El Paso, with the broad trail to the Rio Grande along the eastern base of the Llano Estacado, and which is now the highway of the Camanches and Kiowas of the northern plains. It would thus be brought more directly into contact with the Indians, and nearer to the timbered regions of the Brazos and Red rivers, in which they pass the winter; would occupy the broad trail of their plundering expeditions to the Rio Grande; would separate the northern from the southern Camanches; and, independently of these advantages in a military view, it would occupy a point on the proposed route of travel to the Rio Grande at El Paso.

The main Colorado and many of its tributaries offer desirable sites for a military post as far west, at least, as the 101° of longitude, and somewhat farther if necessary. The mezquite, of large size, is found forming extensive forests, and furnishing an excellent and abundant fuel. Building-stone and lime exist on the spot, and water is found in springs and running streams at almost any point. There is no timber so high up on the Colorado which is fit for the lumber used in the construction of quarters; but as the buildings would necessarily be of stone, it would be requisite to haul but little lumber from points below.

In view of the insufficiency of the military forces in Texas, I have suggested the throwing forward of Fort Chadbourne to the northwest; but there is little question but that another post could be advantageously established between this new position and Fort Belknap, on some tributary of the Double Mountain fork of the Brazos. Good roads should at once be made, connecting these posts with each other, and with the heads of navigation of the Brazos and the Colorado, by the valleys of these streams. I would also suggest, in this connexion, the removal of Fort Arbuckle, which seems of little practical use in its present position, to a point in the valley of the Red river, and considerably farther to the west, and of connecting it by good roads with these two posts, and with Fort Smith or Fort Gibson, on the Arkansas. It would be thus placed on the southern frontier of the "Great Plains," and in the region occupied by the Camanches and Kiowas of the northern prairies during the winter months.

By these arrangements a very fertile and extensive region along the northern frontier of Texas would be thrown open to settlements, which would soon supersede the necessity of the posts. The interval of three hundred miles between the new position of Fort Chadbourne and the valley of the Rio Grande could be occupied by a post to be established at or near the head of Delaware creek, one hundred and seventy-six miles west of Fort Chadbourne, and one hundred and forty-five miles east of El Paso.

At this point water is furnished in abundance from pure, and mineral springs, which form the sources of this stream; grass is good and very abundant over the entire country, and the building-material, of stone or adobe, is furnished in the immediate vicinity. Sufficient wood for fuel is found in the mezquite and dwarf cedar, which cover the ridges in the neighborhood, and lumber to be used on the quarters could be procured from the forests of pine which line the eastern face of the Guadalupe mountains, at a distance of twenty miles. I would suggest that Fort Fillmore, on the Rio Grande, which can be advantageously broken up, as will be immediately exhibited, be removed to this point.

By these arrangements we have a continuous line of posts, at convenient intervals, from the frontiers of Arkansas to the Rio Grande at El Paso, or Doña Ana, separating the Indians of the prairies from those of Texas, confining the Apaches of New Mexico to the mountain ranges on the north, and without increase of the military force. By procuring water on the "Staked Plain," we have a route across the plains to the valley of the Rio Grande, more than half of which traverses a well-watered, well-timbered and fertile country, and one which a very few years will find settled to within three hundred miles of El Paso.

A brief examination of the approaches to this route from the east, and a comparison with the present military road through Texas to El Paso, will readily exhibit its immense advantages.

The great route of emigration to Texas, from Illinois, Missouri, Arkansas, Kentucky, and Tennessee, and the southern route to California, cross the Red river at the little village of Preston, and at the town of Clarksville, one hundred miles lower down.

A broad and well-beaten road also leads from Preston down the valley of the Red river, connecting the towns and settlements. The Red river, as I before stated, is navigable many miles above the town of Preston, and steamboats yearly carry down the cotton and other products of the valley. The point of departure from the Red river is easily accessible, both by land and water, and the distance thence to the Rio Grande, at El Paso, over the route I have described, is six hundred and thirty-nine miles.

The present depot of military supplies of Texas and the Rio Grande, as high up as the town of Doña Ana, has been established at La Vaca bay, and from thence, by the present military route to El Paso, is a distance of seven hundred and fifty miles. Nearly five hundred miles of this distance is through a country destitute of timber, and badly watered, and, although the depot is more easily reached from the east than the proposed point of departure on Red river, yet it is not only much farther from the frontier posts of Texas, but communicates with them by a route far inferior in all respects.

For the defence of the Rio Grande settlements, from the northern terminus of the "Jornada

del Muerto'' to El Paso, a distance of one hundred and forty-two miles, there are at present four military posts, garrisoned by nearly half the military forces in the department of New Mexico. Commencing at the north, these posts are, first, Fort Conrad, which, under another name, has been moved down to the northern terminus of the "Jornada;" Fort Thorne, in the valley of the river and opposite the centre of the "Jornada," a distance of sixty miles from Fort Conrad; Fort Fillmore, at the Bracita, fifty-four miles lower down; and Fort Bliss, opposite El Paso, and forty miles below Fort Fillmore.

The garrisons are in order as follows: Fort Conrad, one company of infantry and one company of dragoons; Fort Thorne, same garrison; Fort Fillmore, three companies of infantry and one company of dragoons; and Fort Bliss, four companies of infantry. We have distributed at intervals of less than sixty miles four military posts, comprising nearly one-half of the troops in the Territory, and for the protection of about one-eighth of the population.

The establishment of Fort Thorne I consider in all respects a wise arrangement. A road has been made connecting it with Fort Conrad, and with the town of Doña Ana, and all military movements and trains are required to pursue this route. The road over the "Jornada" has for many years been the scene of Indian depredations upon travellers and trains of wagons; and as, from its character, it can never be settled, it is likely to require for all times strong military dispositions for its security. Water is very scarce, there is no wood, and the grass is very indifferent.

The small gain in distance (fifteen miles) by no means compensates for these disadvantages, and nothing but the natural indolence of the Mexicans has ever diverted the travel from the valley of the river. That portion of the valley which bounds the "Jornada" on the west is among the finest portions of the arable country in New Mexico, and even partial security will soon secure its settlement and cultivation. The route along the river will then be as safe as any portion of the Territory, and the dangers of the "Jornada del Muerto" will only be mementoes of the past. It would be impolitic in the extreme to attempt any boring for water on this desert, as the road along the river furnishes every possible facility of wood, water, and grass; and the constant use of this route would redeem from solitude the best portion of the Rio Grande. The very success in supplying water on the "Jornada" would render necessary the perpetual maintenance of a strong military force for the defence of the route over it, whereas the settlement and cultivation of the valley of the river would soon leave the forces at Fort Thorne disposable for other purposes. The commander of the department of New Mexico has, in my judgment, exhibited great wisdom in establishing this post, and its good effects are already beginning to be perceptible.

Fort Fillmore, which once occupied an important position opposite the valley and town of Mesilla, has, since the late treaty, entirely lost its consequence, and since the establishment of Fort Bliss, forty miles below, has become absolutely unnecessary. I therefore suggest that it be at once moved to the head of the Delaware creek, east of the Guadalupe mountains, and that its garrison be changed to two companies of dragoons and one of infantry. The establishment of this post would effectually cut off from the settlements below El Paso, and from the route to that place, the Indians of the White and Sacramento mountains, who have been constantly in the habit of carrying their forays into that part of the country; and with these troops in their rear, and near their places of retreat in the mountains, they would be extremely cautious about extending their depredations to the valley of the Rio Grande above.

I suggest these military arrangements after much reflection, and after careful examination of the country and full knowledge of its necessities; and, taken in connexion with a great highway of travel across the plains, I think they will be found by experience to be in every respect advantageous.

CHAPTER V.

Agricultural and Mineral Resources of the Route.

As I have represented at some length in the preceding chapters the facilities presented by this route for a great highway of travel across the plains, and for the establishment of military posts for its security, and for military operations against the Indians, not only in view of the great practicability of the country for such purposes, but in consequence of its extremely favorable agricultural features, I consider it proper to enter in some detail into the examination of this subject.

The opinions I shall express are not based upon the results of superficial observation, but will be found confirmed by an analysis of the soils, and an examination and description of the specimens of grasses and other vegetation which were collected at short intervals.

To the results of these examinations by scientific men, and which will be found under the head of botany and soils, in the appendix to this report, I refer for the amount of confidence to be placed in my statements.

It seems proper to state here that the region of the agricultural resources of which I am about to give a hasty sketch, lies entirely to the west of the limits of possible settlement in the Indian territories west of Missouri.

I will say, first, that with a considerable train of wagons, drawn by mules and heavily loaded, I left Doña Ana on the 12th February—a season of the year the worst possible, when the old grass was in its most unfavorable condition, and the new grass had not begun to spring up—and traversed this route for the first time, over an unbroken country, without losing, during the whole expedition, one single animal.

The mules arrived at Preston, on the Red river, after a journey of this character of six hundred and fifty miles, in better order than when they started; and at no time during the entire journey were they in worse condition than when they left the valley of the Rio Grande.

This simple fact, which will be found confirmed in the journals of the expedition, speaks more strongly than volumes of opinions in establishing the remarkable advantages of the country for the support of stock.

The grama and mezquite grasses, which cover the entire surface, are short and curly, growing very thickly and almost matted, and form a firm, spongy sod. They do not dry up and lose their strength and nutriment during the winter, as is the case with the grasses further east, but actually "cure" where they grow, like hay which has been prepared by the farmer. To this singular fact, and to the extreme abundance of the grass, is undoubtedly due the complete success of the expedition; and the journey across the plains with such successful results during the most unfavorable months, exhibits conclusively the practicability of traversing this route at any season of the year.

Of the valley of the Red river.—This valley is fourteen miles in width from the point at which the route of survey intersected its first tributary, to the crossing of the river at Preston.

About four-fifths are covered with large timber—a few patches of prairie of limited extent, only, sufficing to interrupt its continuity. The immediate valley of the river is about one hundred feet below the gently receding bluffs which border it, and is overgrown by timber of the largest size and best quality—oak, pecan, hickory, elm, &c.

Although the bottom-land is covered with this timber, growing so thickly as absolutely to

prevent any passage through it even on horseback without constant cutting, it is preferred by cotton-planters who have the force to clear it, to the prairie or more sparsely timbered districts to the west. It possesses a soil of black vegetable mould, of such astonishing fertility that it well repays the labor of clearing the land; and I was told by one of the planters who had just commenced making a settlement, that there was no cotton land in America to compare with it. The resources of the valley are so great, and the soil so exhaustless, that it is beginning to attract planters from the cotton-growing States along the Mississippi; and although it is farther from the markets and remote from the conveniences of life, they find it to their interest to make the change.

The occupation of the eastern side of the river by half-civilized Indian tribes who interpose between it and the frontier of Arkansas, is a serious obstacle to the rapid settlement of the valley.

It is of course forbidden to the whites to own land, or occupy themselves in making farms, in the Indian country; and the existence of the very unsatisfactory state of things in regard to law and order on the eastern, seriously retards the settlement of the western side of the valley.

There is little or no security from robbery and outrage of any character, as the facilities for escape into the Indian country east of the river, and the impossibility of securing or punishing a fugitive from justice, have attracted, and will continue to attract, the outlaw and the vagabond.

The valley of the river between the 32d and the 34th parallels of latitude is a thickly timbered region of fertile soil, well watered, and possessing a mild and healthy climate. It produces abundantly all the cereals, and is admirably adapted to the cultivation of cotton. The pasturage is very fine, and is only interrupted by the seasons for two or three months of the year.

Valley of the Trinity, and its tributaries.—The valley of the Trinity, between the waters of the Brazos and Red river, is about one hundred and seventeen miles in width, and contains about equal proportions of prairie and timbered lands along the line of the survey, but a considerably larger proportion of timber lower down. It is a gently rolling country of prairie and oak openings, and presents the most beautiful undulations of surface. The groves of oak timber are so agreeably distributed that each elevated summit of the country affords the most beautiful landscapes, which seem far more appropriate to a well settled than to a sparsely populated country. It is intersected by numerous fresh-running streams and countless springs, and seems, in soil, climate, water, and timber, to present every attraction to the emigrant. It is intersected by the two remarkable strips of very thick timber known as the Upper and Lower Cross Timbers, extending from the "Canadian Fork" of the Arkansas to about the 32d parallel.

The first of these—the Lower Cross Timbers—is about fifteen miles through from east to west, and commences about twenty miles west of the Red river, at Preston; and the second, about eight miles across, is about forty miles farther to the west. The principal growth of these two belts of timber are the post-oak, black-jack, ash, hackberry, pecan, &c. It would be very difficult to find a region of country in the United States of more fertile soil, or one in which the timbered and prairie lands were more beautifully and advantageously distributed. It is settled, though thinly, for fifty miles west of Preston, and connects with that place by the military road, joining the chain of posts along the northern frontier of Texas. The small village of Gainesville is on a tributary of the Trinity, and about forty miles west of the Red river.

Valley of the Brazos.—Separated by a very gentle dividing ridge, we find the valley of the Brazos extending one hundred and fifty miles westward to the summit between its waters and those of the Colorado. It is in all respects similar in character and natural features to the valley of the Trinity, but rather more heavily timbered to a point near the head of the Clear fork. Fort Belknap is placed on the east or left bank of the river, one hundred and seventy

miles from Preston, and exercises a beneficial control over the Indian tribes which inhabit the valley.

The river opposite the fort is seven hundred and thirty-eight feet in width, with a gravelly bed; and when we passed, in April, with a depth of only a few inches. In the immediate vicinity of the post the bluff banks of the stream approach each other to within six hundred yards, and all the material for constructing a bridge is at hand.

The gently rolling country east and west dips with a gradual slope, in most cases of about fifty feet, to the immediate bottom-lands along the river, which do not exceed a mile in width. The valley of the Brazos is also being rapidly settled since the establishment of the post, and thirty-four miles to the west, in the valley of the Clear fork, we came upon a house and a farm of several hundred acres, under cultivation. As we proceed to the west from the Clear fork, the oak and ash timber become much scarcer, until, near the last tributary of the Double Mountain fork of the river, we lose it entirely. It is then replaced by dense groves of large mezquite, which cover at least two-thirds of the country to a point a few miles east of the dividing ridge of the waters of the Brazos and those of the Colorado.

Very extensive fields of bituminous coal crop out along the bluff banks of the main Brazos. The coal is of good quality, and is used in the blacksmith shops at Fort Belknap. The abundance of timber of all kinds common to the valley of the river deprives these coal-beds of the importance they would otherwise possess; but a settlement of the country and the establishment of factories would soon bring them into important notice.

The water of the river is slightly bitter and salty, in consequence of having cut through the immense gypsum region to the west; but animals prefer it to that of the springs of fresh-running streams. Pure water is found in great abundance in the numerous tributaries of the river which intersect its valley at every mile or two, and many springs are found throughout the entire country. Water is readily obtained by digging wells at any point of the surface.

The country drained by the Brazos and its tributaries is more uneven in its surface, and more densely timbered than either the Trinity to the east or the Colorado to the west, and with a climate in all respects delightful; it is a very fertile region, eminently adapted to agricultural purposes.

Valley of the Colorado.—Passing the dividing ridge, we descend upon the tributaries of the Colorado about twenty-seven miles from the main stream. This valley, from the summit of the dividing ridge to the eastern base of the "*Llano Estacado*," is about sixty-seven miles in width, and is intersected in that distance by many small running streams, tributary to the Colorado, and from two to six miles apart. The east side of the valley is about equally divided into "prairie" and forests of mezquite timber, and is much less undulating in surface than the country to the east. The mezquite becomes less abundant on the west side of the river, probably not occupying more than one-fourth of the country, until at the base of the "Staked Plain" it disappears altogether. The soil of the valley of the Colorado is good, but less moist and fertile than that of the valley of the Brazos. The rain is not so abundant as in the valleys of the streams to the east, but falls in sufficient quantity to obviate the necessity of irrigation, as was sufficiently evinced in the fact that although we traversed it at the very driest season of the year, most of the small tributaries of the river were running streams, and few were without water. The Colorado itself was about forty feet in width, and with a rapid current traversed its valley from side to side in a very tortuous course. The low and gently sloping ridges on each side were faced with red sandstone, and the soil was a rich, red loam, which, although light, was very fertile.

Limestone and other building material, with the exception of timber large enough for joists and planking, are readily obtained at any point of the valley; and its agricultural features, although not so eminently favorable as those of the country to the east, are nevertheless good.

The mezquite, a hard and durable wood, grows in extensive forests, is about thirty feet high, and from four to ten inches in diameter.

For fuel, or for ties for a railroad, it is eminently adapted, and exists in an abundance which many years will diminish but little. The yearly burning of the prairies has very seriously obstructed the growth of this timber, as was sufficiently apparent in the scorched and blackened forests west of the Colorado; but settlement and a protection from these yearly conflagrations will readily put a stop to this destruction, and will insure a vast increase of timber over this region within a few years.

The entire region thus drained by the principal rivers of Texas is adapted, from soil and climate, to the cultivation of cotton, hemp, corn, wheat, and tobacco; but from its peculiar character, cotton would doubtless be the most valuable and general of its productions.

I have not dwelt at much length upon the agricultural features of this region, since it differs but little from the settled districts of Arkansas or Missouri; and I refer those who are desirous of more detailed knowledge of the character and productiveness of the soils to the tables of analyses appended to this report.

From the valley of the Red river at Preston we have thus traversed, over a distance of three hundred and fifty-four miles, a belt of well-timbered and fertile country, which projects, like a great peninsula, into the vast deserts of the plains, and have reached a point within two hundred and eighty-five miles of the Rio Grande at El Paso. This remarkable natural feature of the country cannot have escaped the attention of the thousands of persons who, since the discovery of gold in California, have been seeking, with constantly increasing interest, an easily practicable route to the Pacific; and the existence of the "Staked Plain," without water, which interposes between the western limit of this wooded peninsula and the valley of the Rio Grande, has proved, in the absence of the labor and expense of boring for water, which are beyond the means of the emigrant, an obstacle sufficient to counterbalance these advantages and to divert the emigration to different routes. This obstacle is readily and easily removed, and it is to be hoped, in every view, that the estimates for that purpose which I shall present will be favorably considered by the department.

The Llano Escatado.—Of the agricultural resources of the "Staked Plain" but little can be said. It is a high and nearly level table-land, elevated, at its highest line, about 4,700 feet above the level of the sea, and about 500 feet above the headwaters of the Colorado of Texas.

It is nearly two hundred miles in width at its widest point, and extends from the vicinity of the 30th to near the 35th parallel of latitude. On the line of survey it is one hundred and twenty-five miles in width from the valley of the Pecos to the head of the Colorado, and is destitute of water and of timber. Beds of dark-red sand alternate over its surface with patches of hard, pebbly ground, upon which is imposed a thin layer of decomposed gypsum. Over the hard surface the grama-grass is good and abundant, but the belts of sand are overgrown with a coarse bunch-grass about two and a half feet high.

More than one-half of the surface of the plain, along the line of survey, is hard and firm, and furnishes grama-grass in abundance, and the mezquite-root entirely sufficient to supply fuel for all parties crossing it, in whatever numbers. There is no evidence, in natural features, of its existence on approaching from the east or west, and the ascent to its summit and descent from it are so gentle as only to be perceptible to instrumental survey. There are many beds of small lakes and ponds which were dry in the month of March, but which probably contain water during the rainy seasons. There is no living water in its entire extent. It presents remarkable natural advantages of surface for a road, and a supply of water, which can be readily obtained by boring, would adapt it in a high degree to the support of stock.

Although altogether deficient in important agricultural resources, it is nevertheless rich in the immense beds of gypsum which crop out along the Pecos, in bluff banks of selenite fifty feet high, and of a translucency which renders it valuable to the people of New Mexico, who use it for glass. Numerous caves of pure gypsum, of dazzling whiteness within, are found in this entire gypsum formation, which extends over a distance of one hundred and fifty miles along the route, and forms probably the largest gypsum field in the world. As an article of commerc

it would occupy an important place in estimating the resources of the country. With facilities for reaching a market it would, in consequence of its immense extent and the remarkable ease of procuring it, be of great value. It gives a bitter taste to the waters of the Pecos and to some tributaries of the Colorado, but not sufficient to make them unpalatable.

Valley of the Pecos.—The valley of the Pecos at the 32d parallel is from two to four miles in width, and is bordered on the east by the "Llano Estacado," and on the west by table-lands, which descend into it by very gentle inclinations. The bottom-lands are level and very fertile, and the river, with a general direction to the southeast, traverses the valley from side to side in thousands of sinuosities.

Its bed has a very great inclination, which for thirty miles at least above the 32d parallel, and fifteen below it, occasions continuous rapids, and in many places falls of two or three feet. The soil of the level bottom-lands which occupy the bends of the river is, as will be seen from the tables, of great fertility, and the peculiar character of the stream, and the great inclination of its bed, offer unlimited facilities for irrigating the whole of the arable land of the valley. There is no timber, other than the mezquite and a sparse growth of dwarf cedar; but fuel sufficient for a climate so mild and equable could easily be procured, as is the case along the valley of the Rio Grande, from the under-ground forests of mezquite-root on the table-lands.

About fifteen miles below the 32d parallel the river begins to change its character, passing from its rocky bed and a depth of only two feet over the rapids, to a soft muddy bottom and falling banks, and a depth probably at no place less than four or five feet, and in many places fifteen or twenty feet. Very little rain falls in the valley except during the months of July and August, and the same system of farming would be necessary as in the valley of the Rio Grande. The expense of irrigation is very much over-estimated by those not conversant with such matters, and as an evidence of this error it is only necessary to say that corn was worth but 60 cents a bushel in the valley of the Rio Grande, above El Paso, during the months of February and March, while in the Indian country, east of the Red river, and in the State of Arkansas, it commanded a price varying from 70 cents to $1 50. It must be remembered, also, that but an indifferent market for such products is offered in New Mexico, where the stock finds sufficient grazing during the whole year, and where it is entirely unusual to feed corn to animals.

The only sales, or certainly four-fifths of the sales, are made to the government and for military purposes; and it seems reasonable to suppose that a larger demand, by stimulating competition and increasing the crops, would considerably reduce the present prices.

The valley of the Pecos is eminently adapted to this kind of cultivation, and with a demand could supply corn or wheat in almost unlimited abundance. In common with all the low lands in New Mexico, it is wonderfully favorable to the cultivation of the grape, and only needs protection and a market to insure its settlement.

The river, although very tortuous in its course, has always sufficient depth of water for small stern-wheeled steamers from its mouth to a point near the 32d parallel.

Table-lands between the Pecos and the Rio Grande.—Passing from the valley of the Pecos along the northern bank of its tributary, the Delaware creek, we begin to ascend the elevated table-lands, towards the east base of the Guadalupe mountains. The ascent is extremely gentle along the banks of the creek to its head, about thirty miles from the Pecos; but from thence to the summit of the Guadalupe Pass, it is, although uniform, much more rapid. The valley of Delaware creek presents agricultural features altogether similar to those along the Pecos, and can be irrigated with almost equal facility. The creek itself is a succession of small lakes, ten or fifteen feet deep, connected by a swift-running stream, and as it ascends from the mouth the dwarf cedar becomes much more abundant along the ridges. It has its source in a limestone bluff about fifty feet above its valley, and issues from the base of the bluff from seven or eight springs, both pure and mineral. The largest of the pure springs bursts boldly out of the north side of the hill in a stream as large as a barrel, and after a course of probably fifty yards it unites with the small streams from the mineral springs. These springs, the analyses of which will be found

in the appendix, contain sulphur in various proportions—in some barely perceptible, while in others it gives out an odor which is sufficiently perceptible at fifty yards. There are six of these sulphur springs. From the south side of the bluff issues a spring strongly impregnated with soda, and all the springs uniting in one of the small lakes or ponds of Delaware creek form a compound detestable both in smell and taste. The animals, to my surprise, greatly preferred this lake to the pure water of the spring.

That the mineral properties of these springs are very valuable and peculiar, there can bo no question; and the delightful air, and fine, bracing climate of the country will render them, in the event of the construction of a railroad, a resort altogether preferable for health or pleasure to any now frequented in the United States.

To this point it is proposed to remove the present post of Fort Fillmore, and it is to be doubted if a more attractive spot in all respects can be found west of the Mississippi.

Beyond the immediate valley of Delaware creek, the table-lands, which extend uninterruptedly to the valley of the Rio Grande, are, from the absence of rains at convenient intervals, entirely withdrawn from all prospect of cultivation; but overgrown as they are with the grama-grass, abundantly supplied with water, easily accessible, and favored with a climate mild and equable at all seasons of the year, they present advantages for raising and maintaining stock as remarkable as they are limitless.

Sixteen miles from the head of Delaware creek we find the Independence springs, which burst from the surface of the ground in a small valley or depression in the table-lands. They are two in number, and, uniting at a short distance below, they flow off to the southeast in a small stream, which within a few miles becomes dry. There is a sparse growth of the hackberry and dwarf cedar in the neighborhood. These springs are about five feet in diameter; and although a pole ten feet long was thrust into them, the bottom was not reached. Five miles further to the west we reach the east base of the Guadalupe mountains, at a fine spring of pure water; and four miles further, at the southern base of the high peak, we find another large spring, which runs off to the south through a rocky ravine.

There is abundance of large pine timber in the ravines and gorges along the east face of the mountains, and the ridges to the south are overgrown with the dwarf cedar.

Twenty-three miles to the west, and at the western base of the mountain, we come upon the spring and two small lakes, slightly sulphureous, known as the "Ojo del Cuerbo," or Crow spring. These lakes cover four or five acres of ground, and, although shallow, contain abundance of living water. Many wells have been dug in the vicinity, which supply water less impregnated with sulphur than the lakes. Twenty-seven miles to the west are the "Cornudos," or Thorne's wells. These are natural tanks of immense size, distributed through a mass of rocks one hundred and fifty-feet high, piled upon each other in the most singular and grotesque confusion. The water which falls during the rainy season percolates through the crevices of the rocks, and is received in immense rocky basins and reservoirs, capable of containing many thousands of gallons, and entirely sheltered from the sun. Some of these reservoirs are reached by the beds of streams which issue from them when the basins overflow; others are in caves, and some far up the sides of the rocks. By a little labor in deepening and increasing the number of these cisterns, water could be accumulated to almost any extent. Eight miles further are the wells of the "Alamos." About five hundred yards from the route, and on the northern face of an isolated hill, there are seven wells of living water, which, during the seasons of rain, overflow, and are discharged by a small rocky stream along the face of the hill. Twenty-five miles further are the "Hueco tanks," in all respects similar to the "Cornudos." Twenty-four miles from thence we reach the Rio Grande at El Paso.

These immense table-lands, covered with the grama-grass—nutritious at all seasons of the year—and thus supplied with water, have been from time immemorial in undisputed possession of the Apaches, who occupy the valleys among the mountains; and notwithstanding constant

danger and enormous losses, the Mexicans cannot refrain from pasturing their stock in this region of plenty.

The valleys between the Guadalupe mountains and the Hueco and Sacramento range, and between these latter mountains and the Organ range, are occupied along their lowest lines by the Salt lakes, which supply the whole country with that commodity, and which have been the occasion of many bitter controversies.

The evaporation of the water leaves a deposite of pure salt several feet in depth, into which trains of wagons are driven and loaded. It is quite impossible to estimate the extent or value of these dry lakes; but the quantity of salt is so enormous, and so easily obtained, that, with cheap communications with a market, they would supply the United States at a cost far below the present market prices.

The three ranges of the Guadalupe, the Hueco, and Organ mountains occupy the summits of these table-lands, and are, so far as investigations have extended in constant apprehension of attacks from Indians, prolific of the precious metals. The Sacramento and White mountains (a continuation of the Hueco range) have long been marked in old traditions, and recent statements, as regions rich in gold and silver; but the constant and immediate danger from Indians, who are to the last degree jealous of any encroachments upon their lands, has hitherto prevented any close examination.

On the west side of the Organ mountains, which bound the valley of the Rio Grande, valuable silver and lead mines are found, extending over a continuous distance of twenty-five miles. The want of means to open them, and the ignorance of mining, characteristic of the New Mexican, have altogether prevented any development of their richness, and it has only been within the last eighteen months that anything like a serious commencement has been made.

Mr. Stevenson has opened a mine about fifteen miles from the river, at Doña Ana; and, notwithstanding the impossibility of getting an experienced miner, and the crude and imperfect manner of smelting he has been compelled to adopt, the results have been exceedingly profitable. The ore is powdered between two stones, and the smelting is done without one convenience common to the States. The refuse probably contains half as much silver as the original ore; and, notwithstanding this, from a mule-load of three hundred pounds of the ore he gets $18 of silver.

Many specimens from these mines were brought in, and their analyses will be found in the appendix to this report.

Valley of the Rio Grande.—That portion of the valley of the Rio Grande, of the agricultural resources of which I shall present a brief sketch, is embraced between the southern terminus of the "Jornada del Muerto" and the town of San Elizario, in Texas. The only cultivated lands within this distance of eighty-five miles are the immediate bottom-lands along the river, which can be conveniently irrigated.

At the northern extremity is the town of Doña Ana, on the river and about seven miles below the Jornada. Extending from this village a distance of fifteen miles along the east or left bank of the river are the towns of Las Cruces and Las Tortugas, and the military post of Fort Fillmore. Opposite we find the valley and town of Mesilla.

The settled portion of the Mesilla valley is about ten miles in length along the river, and from one to three miles in width, to the base of the table-lands. It contains a population of about 3,000, and notwithstanding its equivocal position during the disputed question of boundary, and the constant annoyances and discouragement to the inhabitants in consequence of so precarious a condition, it has thrived wonderfully, and now raises nearly double the amount of products of the valley on the east side of the river. The village of Mesilla contains a population of 2,500, although first settled as late as 1850, and doubtless the settlement of the vexed question of jurisdiction will give a renewed impulse to its progress.

The oldest town in this part of New Mexico is Doña Ana, which, although settled as early as 1842, is nevertheless the least populous and thriving of the villages I have named.

The post of Fort Fillmore has been established opposite the southern extremity of the Mesilla

valley, and about fifteen miles below Doña Ana. The next settlements along the river, with the exception of the abandoned ranch of "Frontera," are the town of Molino, at the rapids of the Rio Grande, about fifty-four miles below Doña Ana and two miles above El Paso, and the town of Franklin, two miles below.

Molino has been but recently laid out into lots, but occupying the point at which a railroad must intersect the Rio Grande; and presenting by far the most practicable point for crossing the river within many miles, it bids fair to become a place of much consequence. Franklin, opposite El Paso, is at present occupied by four companies of the 8th infantry, and is almost entirely the property of Mr. James McGoffin, a wealthy and enterprising citizen of El Paso county.

The small villages of Isletta and San Elizario are twelve and twenty-five miles, respectively, below El Paso.

At Frontera, about five miles above El Paso, the Rio Grande commences to make its passage through the chain of mountains which intersect its course, and to a point immediately in the neighborhood of Molino it is bordered closely on both sides by a range of high and rugged mountains. At Frontera, four miles above, the range on the west side subsides into the vast level table-lands, which extend with little interruption many miles to the westward; but on the east side the mountains gradually depart from the river, becoming more rugged and lofty, until they unite on the "Jornada del Muerto" with the continuous ridges of the Rocky mountains. The river cuts through them between Frontera and Molino, by a succession of rapids, and at one place a perpendicular fall of two or three feet, and this passage has, from the period of its discovery by the Spaniards, been known as El Paso. The Mexican *town* of that name is about two miles below the debouchure of the river from the mountains.

With the exception of the limited strip between Frontera and Molino, the immediate valley of the Rio Grande is from two to five miles in width, and perfectly level, and the river traverses it from side to side in many sinuosities.

These level bottom-lands can be readily irrigated from the river, and possess a soil which, although not deep, and containing rather too large a proportion of sand for the notions of farmers in the United States, is nevertheless extremely fertile, and well adapted to the production of all the cereal grains.

The system of irrigation renews the fertility of the soil by spreading over it every year a fat deposite several inches in thickness, which is brought down in suspension by the river, and to this deposite is undoubtedly due the fact that the Mexicans, for so many successive years, have been able to continue the same crops upon the land. The soil is only about four or five inches deep, and for cultivating it the Mexican implements have been conclusively shown, by experience of several years, to be the best.

The wooden plough which they use barely enters the earth sufficiently to turn up three or four inches in depth, and they thus never pass below the yearly deposites of the river. The iron plough, on the contrary, passes several inches below this, and turns up a soil more than four-fifths of which is sand, and consequently of little productiveness. As an evidence of the results, it will suffice to say, that of two fields of the same size contiguous to each other and identical in soil, the one cultivated with great care by the government, after the American fashion, the other the property of an old Mexican, who cultivated it himself, without assistance, the products were little or nothing for the first, and a crop averaging from thirty to forty bushels of corn to the acre for the last.

The immediate valley of the river between Doña Ana and Frontera contains about 128,000 acres of arable land; and to form an estimate of its agricultural value, it will be sufficient to exhibit the products of the little strip of cultivated ground in the Mesilla valley for the year 1853. This can scarcely be considered a fair test, as the land was first settled in 1850, and the constant difficulties resulting from its equivocal relations with the two governments, and the impressment of the men into the Mexican army, have seriously interfered with its agricultural

productions. There are about 16,000 acres in what is commonly known as the Mesilla valley, of which about 10,000 acres are under this partial cultivation.

The products for the year 1853 were as follows, viz:

Corn, 50,000 bushels, at 70 cents	$35,000
Wheat, 7,000 bushels, at $1	7,000
Beans, 15,000 bushels, at $2	30,000

and melons, fruits, and vegetables, in the most unlimited profusion.

For a population, therefore, of about three thousand, we have products which, with a very indifferent market, and under very unfavorable circumstances, have been worth about $80,000.

An approximate estimate can be formed from these data of what would be the value of the products of these lands, with proper encouragement of security and good markets.

The most valuable feature, however, of the valley of the Rio Grande, is yet but partially developed; and as it ministers to the luxuries rather than to the necessities of life, it cannot, in the absence of demand for such things, occupy a very important place in the present wealth of New Mexico. I refer to the peculiar adaptation of the valley to the culture of the grape. The east side of the Rio Grande is faced by chains of lofty mountains, at an average distance from the river of fifteen miles, which, at San Felipe at the north and El Paso at the south, impinge directly upon the banks. A semi-circular sweep of country is thus enclosed from the northern and eastern winds, and in consequence we find within it a very mild and equable climate, little subjected to the changes of the seasons. The river having a general course to the southeast, and the ranges of mountains on the east side being nearly parallel to it, the whole of this area has a southern and western exposure, and with a soil sufficiently fertile, and of great warmth, it is most wonderfully adapted to the culture of the grape. It attains here a flavor and richness unknown to any grape I have ever seen in the United States, and is produced, where cultivated, in the most profuse abundance.

An examination of the character and climate of this region exhibits a striking resemblance to those of the south side of Madeira, and it is much to be doubted whether this portion of New Mexico and Texas is at all surpassed in the quality of its grapes, even by that favored island.

As I said before, grapes and wine being articles of luxury rather than of necessity, the people of New Mexico are little able to develop this rich agricultural feature of their country; and without facilities for reaching a market, this source of wealth is completely useless.

There are comparatively few vineyards in the country, but they produce most abundantly a delicious grape, and the wine, although very rudely and imperfectly manufactured, and drunk in the same year, and probably within a few months after fermentation, is of very fine flavor, and of several varieties. It is a matter of regret that no specimens of the wines were brought in for examination.

I am convinced that one of the most important elements of the future wealth of New Mexico is to be found in its peculiar adaptedness to the manufacture of wine, and it needs but opportunity and encouragement to confirm the truth of this opinion.

The excellent pastoral character of the table-lands, which have been before referred to, has made New Mexico, for the present, peculiarly a stock country; and the expense of maintaining all kinds of stock is so little, that the people are able to drive immense herds annually to California, and sell them at a very large profit. These expeditions are attended with great difficulty and some danger, and it is with much reluctance that the New Mexican overcomes his two besetting evils, timidity and indolence, sufficiently to induce him, even with the prospect of the largest gains, to undertake the journey to California.

Sheep and mules, because more easily taken care of, are probably the most numerous of their possessions of this kind; but the country is remarkably favorable to any kind of stock, both in climate and pasturage.

A brief review of this subject exhibits the three great natural divisions of the country along

the route, to which I referred in the beginning of this report, and a detailed examination of them has shown but one strip of country which is not rich in wealth, either agricultural or mineral.

It would certainly be difficult to find, over a district of such immense extent, less desert country.

CHAPTER VI.

Of Boring or Digging for Water on the "Llano Estacado."

The only natural obstacle presented by this route is the absence of water on the "Staked Plain," and to obviate this difficulty two methods can be proposed, and they will be considered separately. The first is by digging wells, or constructing artificial tanks, and the second by boring astesian wells.

To justify the opinions I shall express as to the practicability and relative advantages of either process, a brief sketch of the conditions necessary to success in each case would seem to be necessary.

There are two classes of springs from which the two descriptions of wells above mentioned are supplied—first the shallow, and, second, the deep-seated springs. The first of these is dependent for its supply of water upon the rains which fall upon the surface of the limited district of country in which these springs are found.

The water falling upon the surface of the ground percolates through the soil until it encounters a stratum of rock or clay, impervious to water, and follows the lowest lines of this stratum until it appears at the surface. It follows from these conditions that shallow springs are directly affected by the quantity of water which falls in the immediate neighborhood, and in consequence, during seasons of drought, they frequently become dry.

There are, of course, basins or circumscribed tracts of land, in which the immediate surface of the ground is impervious to water, and in such districts we find lakes, ponds, or swamps.

Deep-seated springs, on the contrary, are found beneath the impermeable stratum, which is the base of the shallow springs, and are only affected by the rain-fall remote from the points at which the springs burst out. The strata of the earth, originally deposited in a horizontal position, have been upheaved by natural causes along the lines of the mountain ranges, and the strata thus dislocated present over many miles of country, and most generally in the vicinity of the mountains, their edges exposed upon the surface.

Where the strata are composed of alternate beds of permeable and impermeable character, the rain which falls upon the edges exposed by dislocations, and the descent of the water occasioned by the melting of the snows on the mountains, would completely saturate the permeable stratum, and the water would continue to follow its line of greatest descent.

If we suppose a permeable stratum of this character to be interposed between two impermeable strata, the water must continue between them, until the stratum containing it is exposed at the surface at a lower level.

By boring, therefore, at any point of the surface of the upper stratum, water would be procured as soon as the water-bearing stratum was reached, which would rise in the shaft to the height of the point of exposure of the stratum at the upper surface, less friction and loss of water through fissures.

There are many circumstances to qualify this state of things, such as "faults," (or interruption of the continuity of the strata by breaks,) the giving out, as is sometimes the case, of the water-bearing stratum, &c. &c.; but most generally there is no great difficulty in ascertaining with some considerable certainty the prospects of success in these borings, before commencing the work.

These deep-seated springs are not nearly so much affected by the rain-fall as the land springs,

since they not only receive their supply of water at remote points from this source, and from the melting of the mountain-snows, but they are sheltered from the air and sun, and protected from the consequent evaporation.

When the strata fulfilling these conditions, and out-cropping at high altitudes, can be traced continuously without interruption, the boring of artesian wells will always be successful.

I will therefore, with this brief sketch, proceed to examine the Staked Plain, with a view to the supply of water which can be procured from the two classes of springs above referred to.

Geological structure of the Llano Estacado.—The upper geological formations of this plain, according to Mr. Jules Marcou,* are, first, the Jurassic, 700 feet thick; and, second, the Trias, 3,000 feet thick.

Beginning at the upper surface of the plain, the Jurassic consists of super-soil, white limestone with fossils, yellow sandstone, blue clay, compact white limestone, oolitic white sandstone, and red and variegated soft sandstones: the Trias, of red friable sandstones, with red and gray clay—in a word, variegated with interpositions of beds of sandstone and dolomite, or magnesian limestone.

The strata of the Jurassic and Trias outcrop at the eastern base of the Guadalupe mountains, and at an altitude of 800 feet above the highest line of the Llano Estacado. From their line of dislocation they have a very gradual dip to the east-southeast, and are uninterrupted as far, at least, as the headwaters of the Colorado of Texas, at which point the white oolitic limestone of the Jurassic outcrops, and from beneath it issue the springs forming the sources of the Colorado.

These strata, alternately permeable and impermeable to water, fulfil all the conditions necessary for the success of artesian wells. They are cut through by the Pecos, which interposes between the "Llano" and the Guadalupe mountains, down to the white oolitic limestone of the Jurassic, which forms the bed of that river. In boring, therefore, upon the Staked Plain, it would be necessary to pass entirely through the whole of the Jurassic above this limestone, or a distance of from four to seven hundred feet.

In confirmation of the belief that boring would be thus successful, I quote from the report of Mr. Marcou.† "These rocks of the Llano Estacado (the Jurassic and Trias) dip gently to the east-southeast, and as the heads of the strata outcrop at the foot of the Rocky mountains, called here Sierra Guadalupe, Sierra Sacramento, &c., in boring artesian wells on any point of the Llano, abundant columns of water would be found to gush out over this immense plain; so that the want of water is not an objection to the establishment of a railroad on the Llano Estacado, for it may be obtained anywhere."

The upper surface of the "Llano" is very gently undulating, and contains many shallow basins, which fill with water during the rainy season—the months of August and September. The basins are so shallow, and so large a surface of water is exposed to evaporation, that these ponds are dry during a great portion of the year.

It would be easy to dig wells or tanks in the beds of the lakes, and by conducting into them by ditches and drains all the water which falls upon the surface, a very large supply could be accumulated. It is impossible to say how much, but certainly sufficient to supply all travelling purposes for the whole year. This process would be somewhat cheaper than that of boring, but the supply of water would be less certain and much less abundant.

Wells, also, dug at any point of the plain, would supply water which has percolated through the loose permeable soil, and which is retained by the impermeable stratum of limestone below. The average depth of such wells would probably not exceed sixty feet, although at some points it might reach one hundred and fifty.

In all respects the artesian wells would be preferable. The water would, from what I have stated, be delivered at the surface, and would probably rise far above it; and instead of arrange-

* See the preliminary report by Mr. Marcou upon the collection. Preliminary Reports, 1st edition, 8vo. Washington, 1854.
† Ibid.

ments for drawing it up—which would require too much time and labor when large numbers of animals were to be supplied—the artesian wells would be the sources of running streams.

The tanks would also require to be protected from animals, and the Llano Estacado could only be occupied by the few domestic animals which could be watered by hand.

The process of boring artesian wells is well understood in this country; and by such means large districts of country have been redeemed from unproductiveness. The success of such wells upon the Llano Estacado would not only be of incalculable value to the travelling community, and in the construction of a railroad or wagon-road, but would open to occupation an extensive grazing region which is now doomed to solitude.

In the outfit of a party sent for the purpose of boring or digging, the expenses would be identical up to a certain point, and the number of persons required for each process about the same. It would be both economy and expediency for the government to conduct the work through its own officers, in preference to making contracts for that purpose; and with this view it would be well to purchase boring instruments, provisions, and transportation.

One set of boring tools would be sufficient for many such wells, unless under extraordinary difficulties of ground, which are scarcely to be anticipated on the Llano Estacado.

The wagons would be necessary to haul water to the working-parties; and at the conclusion of the work, both mules and wagons would command a price equal at least to two-thirds of their original cost.

In boring upon the Llano Estacado it would be preferable, if only one experiment is to be made, to establish the depot camp on the Pecos, for the reason that the comparative proximity of New Mexico would be an object in facilitating the supply of the party with materials and provisions. Should an appropriation sufficiently large, however, be devoted to this object, it would seem to me in all respects advisable to commence the work at both sides at the same time.

For entire convenience four wells, at intervals of twenty-five miles, would be necessary between the head of the Colorado and the Pecos, and the whole number could be bored at the same expense and in half the time as by commencing at one side only.

Allowing two months from the time of leaving the settlements to the commencement of the work, which I would consider sufficient, and an average depth of boring of six hundred feet, the time necessary for the completion of each well would be about six months. This time is arrived at by allowing an average depth of three feet for each day's boring. Through hard rock about eighteen inches a day can be made, and through sandstone and soft limestone about six feet. From what I have stated concerning the Staked Plain, a great proportion of the boring would be through soft sandstones and limestones. Some harder beds would be encountered, but of extent comparatively limited.

It would seem to me in all respects advisable to appropriate for the boring of all the wells required, at once, since eight-tenths of the expense would be in the purchase of tools and transportation, and the cost of each additional well would only amount to the cost of provisions and the wages of the party.

I append below estimates for each process.

ESTIMATE FOR ARTESIAN WELLS.

Tools, rods, augers, chisels, derrick-irons, &c., for boring 700 feet	$1,250 00
Travelling forge and equipments	500 00
Wooden tubes for 700 feet	250 00
Pay and subsistence of men for eight months	8,016 00
Cost of wagons and mules for transporting provisions and tools	9,500 00
	19,516 00

For each additional well	$5,472 00
Total cost of four wells	35,932 00
From which deduct sale of mules, wagons, and boring instruments	7,400 00
Final cost	28,532 00

The estimates for tanks or shallow wells would approach nearly to the same sum. The cost of tools would be less, and the time would be somewhat shorter, but there would be no important difference in the estimates.

The estimated cost of artesian wells upon the Llano Estacado is very large, and has been made with a view to every possible contingency which may arise. I consider it in all respects sufficient, and with such an amount I would feel certain of success.

The construction of these wells on the Staked Plain is alone necessary for the establishment of a route of travel across the plains in all respects favorable, and one which, with great advantage to our Indian relations, can be occupied by a chain of military posts, which, in their locations, will fulfil every condition necessary or desirable in selecting sites for military posts in the Indian country. The establishment of such a route, and one thus protected, will open to settlement and cultivation an immense region of fertile country which is now alone occupied by bands of wild Indians. It seems but proper, therefore, that I should invite the attention of the department to the great importance of considering favorably the estimates which I have presented; and I do so with the full conviction that the sum asked for will insure complete success.

CHAPTER VII.

Construction of a Railroad along the Route, and its Estimated Cost.

The construction of a railroad across the plains necessarily presumes the establishment of a wagon road along the route, and of a chain of military posts for its protection. For the first, certain facilities of ground, and the supply of wood, water, and grass, are absolutely requisite. In the establishment of military posts, the agricultural capacities of the country, and the effects of the posts upon Indian relations, are matters to be carefully examined. Before approaching the question of the railroad, therefore, it has seemed to me desirable to enter fully into the examination of these subjects; and I have exhibited in the previous chapters a few of the most important advantages presented by the route near the 32d parallel, and have explained as clearly as possible the means for obviating certain natural obstacles which interpose to modify them. A determination of the bare question of practicable grades is by no means sufficient, since easy grades may be obtained over immense districts of barren country, unfit for human habitation, and in which it would be next to impossible to keep up the military stations which, for all time, would be necessary for the security of the road. There are a few important requisites absolutely indispensable, and I have thought it proper to give in detail the capacity of the route I have examined for supplying them.

It appears from the preceding part of this report that a large proportion of the facilities which may be considered as desirable are found along the route near the 32d parallel, and that the few natural obstacles which present themselves are obviated with little labor and expense.

Three of the most important elements which enter into the construction of a railroad are—

1. The possibility of obtaining practicable grades.
2. The capacity of the country to supply material for construction and for daily use.
3. The facilities for delivering the iron for the road, and supplies for the working parties at points along the line.

In considering these questions, the same natural divisions of the country to which I have already referred, may be properly used, and will be examined in detail.

First Section, 352 miles—*From Red river to eastern base of the Llano Estacado.*—It is to be borne in mind that the ascents and descents referred to in this chapter are along surface lines, and are in every case steeper than it would be either necessary or desirable to establish the grades. For convenient reference, I have appended to this chapter a table exhibiting more in detail the ascents and descents for each section, and the distances between the stations.

The eastern terminus of the line surveyed was at Preston, on the south side of Red river, and in latitude about 33° 45′. As I do not consider this point well selected, either for passing the river or in view of a continuation of the railroad eastward, I shall omit any reference to the cost or plan of a bridge to cross Red river.

In ascending from the immediate banks of the river to the "Divide" between its waters and those of the Trinity, the route for the first six miles pursues, through heavy timber, a gentle ridge, dividing the waters of two small streams which flow into Red river above and below Preston. The surface line of ascent in this distance is quite regular, and amounts to 66.3 feet to the mile, which could be reduced, by gaining more distance, to almost any desired grade.

From this point to the eastern edge of the Upper Cross Timbers the ascent is 676 feet in a distance of 59.6 miles, or 9.8 feet to the mile. The country, about equally divided between

prairie and timber, is gently undulating in surface, and no abrupt ascents or descents occur. A grade of fifteen feet to the mile could be readily maintained over the entire distance. There are three streams to cross, each of which is about twenty yards in width, and approachable nearly on a level. All the materials for constructing the wooden bridges required are at hand at each point. These streams are, first, Big Mineral, tributary to Red river, and the Clear and Elm forks of the Trinity.

The Upper Cross Timbers—65.5 miles west of Preston—are about ten miles through from east to west, and are bounded on the east by a bluff or table-land 256.5 feet above their lowest line. The country is rough and broken in the Timbers, and the embankments and excavations would be comparatively heavy.

Descending from their eastern edge, we pass for the first five miles through a descent of 256.5 feet, or a surface line of fifty-two feet to the mile.

From the lowest line of these Cross Timbers to the bluff banks of the Brazos, a distance of 85.2 miles, we ascend 304.9 feet, or an average ascent of 2.7 feet to the mile. The country continues gently undulating along the line of survey, and contains a rather larger proportion of timber. There are many small streams, or rather threads of water, which descend each way into the Trinity and Brazos on the south, and the Red river on the north. The excavations and embankments would be very slight. The only stream to be crossed is the west fork of the Trinity, about twenty yards in width, and with gentle approaches.

The Brazos is bordered on both sides by bluff banks of the same general level of the country, and from which it would not be necessary to descend in order to pass the river. At the point of crossing, the banks approach to within 1,600 feet of each other, and leave a water-way of 738 feet, occupied by the immediate bed of the river. All the materials for constructing a bridge, both wood and stone, are found upon the spot. Along these bluff banks large coal-fields crop out, and from them bituminous coal of good quality can be readily procured.

From the Brazos to the crossing of Clear fork the country is more undulating, and in this distance of 32.4 miles we ascend 402.1 feet at the rate of 12.6 feet to the mile. The Clear fork is about forty feet wide, and presents no obstacles to approach. Timber of large size is found on its banks.

In passing from the Clear fork to the Double Mountain fork of the Brazos, an ascent is made of 1,755.8 feet in a distance of ninety miles, or at the rate of 19.5 feet to the mile. It would be difficult to reduce this grade much, as the whole surface of the country is so uniform that the ascent is barely perceptible at any point. From thence to the "Divide" of the waters of the Brazos and Colorado, an ascent is made over a distance of eight miles at the rate of forty-five feet to the mile. This rate could be reduced as much as would be considered advantageous.

At the crossing of the Clear fork of the Brazos the oak timber disappears, and is replaced by extensive forests of mezquite. This timber is hard and durable, and covers at least one-half of the country between the Brazos and the dividing ridge between its waters and those of the Colorado.

There are no streams of importance to cross, although many small tributaries of the Clear fork and Double Mountain fork of the Brazos intersect the route at short intervals.

From this divide we descend to the Colorado 308.1 feet, in a distance of 22.8 miles; an average descent along the surface of 12.1 feet to the mile. The timber (mezquite) is not so plenty west of this divide as east of it; but abundance is found for construction and use.

The Colorado is about forty feet wide, and can be readily approached; its banks being but little below the general level of the country.

Water is abundant, although the water of the river itself is slightly brackish. From the Colorado to the Sulphur springs, at the east base of the Llano Estacado, the ascent is 319 feet in a distance of 44 miles, or 6.3 feet to the mile. The mezquite becomes much scarcer until, about 10 miles east of the springs, it disappears. Water is abundant in the small streams tributary to the Colorado.

Timber for building.—From the Red river to the Clear fork of the Brazos, 187.5 miles, the timber is very abundant and of the same character as that found along the streams and ridges of Arkansas and Missouri—oak, elm, ash, pecan, &c. The most valuable for use in construction is the post-oak, which is entirely convenient at all points between the Brazos and Red rivers. This oak is from eight to fourteen inches in diameter, and about thirty feet in the clear or from the ground to the first branches. It is perfectly straight and without knots, and each tree would furnish at least three ties.

The mezquite, which replaces the oak west of the Clear fork, although more durable, is not so well adapted for ties. It is about thirty feet high, but more crooked and much more interrupted by branches, which grow out nearly horizontally. It is from eight to twelve inches in diameter, and, although not so well adapted for ties as the oak, would, nevertheless, furnish them immediately on the line at any point.

Of the building-stone.—For observations upon the characters of the stone found along the route, and upon its adaptation to purposes of construction, I refer to the geological report of Mr. Blake.

It is my opinion, therefore, that this section abounds in every desirable material for the construction and use of the railroad, and that grades are readily attainable which are in all respects favorable.

The head of navigation of the Red river is far to the north of the eastern terminus. At fifty miles west, the head of steamboat navigation of the Trinity approaches to within 40 miles; at 170 miles west, the head of navigation of the Brazos approaches to within 85 miles; and at the eastern base of the Llano Estacado, 354 miles, the head of navigation of the Colorado is within 175 miles.

For this section, therefore, we find every combination of advantages which exist along any railroad route in the United States; and in estimating the cost of the road, it should not be found to differ much from the most favored locations of railroads within the old States.

Estimated cost of first section.—The survey of this route was not, of course, sufficiently in detail to enable any accurate computation for excavations and embankments, or plans or estimates for bridges, to be made; and therefore, in estimating the cost, a comparison must be made with roads in the United States which have been constructed in a region nearly similar to that in question.

It would be next to impossible to find a railroad in the United States, without going to the prairies of northern Illinois, which can compare in facility of ground or other advantages with this section of the route, near the 32d parallel; but it will answer the present purpose to make the comparison with the New York and Erie railroad.

The total cost of this road per mile was $45,652. Assuming this amount, therefore, as a basis, and adding ten per cent. for contingencies, we have $50,000 per mile (nearly,) and for the whole distance of 352 miles $17,600,000.

This estimate I regard as very large, and one which will fully cover every possible contingency.

SECOND SECTION, 125 MILES.—*Llano Estacado.*—From the Sulphur springs of the Colorado the ascent to the Staked Plain is so gentle and uniform as to be barely perceptible, and no bluff nor unusual swell of ground marks its existence.

To the summit-level of the plain the ascent is 423.6 feet in a distance of 89.1 miles, or an average ascent to the mile of 4.8 feet. Neither excavation nor embankment would be required in this whole distance, as the ascent is both gradual and uniform, and uninterrupted by hill or ravine.

The descent to the Pecos, although more rapid, is in all respects similar; and so well adapted is this section to the construction of a railroad, that, with the exception of transporting the ties, no work is required. The surface line from the summit-level to the Pecos descends at the rate of 18.3 feet to the mile, over a distance of 35 miles.

There is neither timber nor water upon this section, and for the supply of the latter requisite boring would be necessary. As I have explained, in a previous chapter, the process and cost of the boring required, it is unnecessary to refer to it in this place.

Timber for ties and for fuel is found very near the east side of this section, and within fifty miles of its western limit. It would therefore be requisite to transport the ties over an extreme distance of eighty-seven miles, to the summit of the plain.

Rocks.—Building-material of limestone and sandstone is very abundant, and can be procured at any point. The Pecos river, at its intersection with the 32d parallel, is about forty yards in width, and descends through many rapids over a bed of compact silicious limestone. A stone bridge could be constructed at little cost from material found on the spot.

Cost of construction.—In estimating the cost of a railroad over this section, it would be necessary to reduce very much the estimate which has been made for the section east of it, in consequence of the very great and very unusual facilities of ground. Instead, therefore, of adding to, it will be in all respects advisable to reduce, the assumed basis.

Assuming, therefore, the cost of the road used in estimating for the first section, and reducing it by ten per cent., we have for the cost per mile of the road over this section $40,000 (about,) and for the total cost $5,000,000.

Although the additional expense of boring for water and transporting the ties will be necessary on this section, yet the work for grading is in all respects so much lighter as to compensate certainly for double the expense required for these purposes.

THIRD SECTION, 169 MILES—*From the Pecos to the Rio Grande, at El Paso.*—This section is in all respects different in natural features from those which precede. It consists of elevated table-lands, whose highest lines are occupied by three ranges of lofty mountains—the Guadalupe, the Hueco, and the Organ ranges. The latter is completely turned by the line at its southern extremity, and need not, therefore, enter into the consideration. The controlling points of this section are the Guadalupe Pass and the pass through the Hueco mountains.

In approaching the Guadalupe Pass from the Pecos, the line is nearly straight, and to the head of Delaware creek ascends 102.6 feet in a distance of thirty miles, or 3.5 feet to the mile.

The country along Delaware creek is uniform, and the ascent is not abrupt at any point. Water in abundance is found along the creek, which is a constantly running stream.

From the head of Delaware creek to the summit of the Guadalupe Pass the ascent, though rapid, is quite uniform, and the line straight. It might probably be considered advisable to reduce the grade on this part of the line; but as it could easily be overcome on the direct line, it would be questionable whether any change would be advantageous. The pass is elevated 1,545 feet above the head of the Delaware creek, which gives, for a distance of 24.4 miles, an average ascent of 61.8 feet to the mile. The eastern side of the mountains immediately contiguous to the line is faced with pine timber of large size, and abundant springs of water break out at several points. All the rocks of the "Trias," before referred to, are found along the line from the Pecos to the mountains, and furnish abundantly the building-material described for the first section.

In descending from the Guadalupe Pass to the table-lands west of this range, the first serious difficulty in the construction of a railroad was presented.

The summit of the pass is at the east base of the mountains, and from thence to the Ojo del Cuerbo a descent of 1,824.8 feet is made in a distance of seventeen miles. The present wagon-road descends abruptly from the summit of the pass to the bed of a rocky ravine, and at a distance of 3.8 miles is 1,227.8 feet below it. The road then turns abruptly to the northwest, and, crossing several spurs which project in a southerly direction from the high peak, descends to the plain.

I at first thought it might be possible to descend more gradually into this dry bed, and to pursue it to the plains on the west side of the mountains, but I found the bed of the stream so much inclined as to make the grade impracticable. This ravine leads from the south point of

the mountain in a southerly direction, and reaches the plain at a distance of eight miles—having accomplished a descent of 1,800 feet in that distance. Its eastern side is an abrupt rocky precipice 1,000 feet above its bed, and on the west it is bounded by a narrow spur of the mountains, which descends to the plain with a slope even greater than that of the ravine. The west face of the mountains is perfectly uniform, and interrupted neither by spur nor ravine, and has a gentle slope to the plain of the salt lakes, along which, descending diagonally, any grade could be obtained. It became very important, therefore, to find some method of passing, with practicable grades, from the east to the west face of the mountains. This, after some examination, was accomplished, by passing round the south point of the range, and close under the high peak. This, however, would require some heavy work, principally the filling up or bridging over of two narrow and deep rocky ravines, which penetrate to the very face of the precipice which terminates, at the south, the high summits of the Guadalupe mountains. Two short curves and a deep cut at the point of entrance to the pass from the east would also be required.

By these means we reach the western face of the mountains at a distance of three miles from the summit of the pass, and with a grade of 108 feet to the mile. From thence, descending diagonally along the face of the mountains, the plain of the Salt lake is reached by any grade which may be considered advantageous. The work over the short distance of three miles along the south face of the mountain would be heavy, but all materials for embankments or bridges are at hand.

A map and profile, on a large scale, exhibit the position of the line and of the wagon road, with the descents along each.

It is proper to remark that the line of survey was not carried over this immediate line further than the determination of the relative heights of the points on the east and west faces of the mountains, and the distance between them was computed. A reconnaissance was made, however, sufficiently close to be convincing of its practicability.

From the Ojo del Cuerbo, along the table-lands, we reached the "Cornudos," at a distance of twenty-four miles, and with a gradual and uniform ascent to the mile of 23.8 feet. At the Cornudos are the immense natural tanks which I have already described, and which by enlargement would supply abundance of water.

From the Cornudos to the "Alamos," near the springs, the line still continues along the table-lands, and over a distance of 8.2 miles ascends at the rate of 26 feet to the mile. The springs of the Alamos supply water in abundance. From thence to the east base of the Hueco mountains, a distance of 20.4 miles, the ascent is 0.9 foot to the mile. The ascent is quite uniform, and no grading would be required.

From the east base of the Hueco mountains an ascent of 227.1 feet, over a distance of 1.7 mile along the wagon road, is presented, to the summit of the pass. No difficulty, however, in obtaining any desirable grade occurs at this point. The faces of the hills are very uniform, and descend gently to the plain, and are approachable from the east at any point. I have therefore increased the length of ascent to 3.7 miles, which gives a grade of 57 feet to the mile. From the summit of the pass the wagon road descends rapidly into the dry bed of a ravine, which conducts to the table-land west of the mountains, at a distance of 3.8 miles, and through a descent of 219.3 feet to the mile. The hills, however, which border the ravine on each side, descend into it gently and with a slope quite uniform, and the line passes diagonally along their face, with a grade of 79.8 feet to the mile, and a gain of seven miles of distance. The descent to the plain is made at a point four miles north of the low, isolated range of hills in which are found the Hueco Tanks. Water and building material of stone are readily obtained. The cuttings along the face of the hill present little difficulty, and no lateral ravines interrupt the uniformity of the slopes.

From the point at which the descent to the plain is made, the line is straight to the highest line of the table-land near El Paso, passing close along the north face of the isolated hills which contain the Hueco Tanks. An ascent is made of 56.5 feet over a distance of 27 miles,

or 2.1 feet to the mile. The distance between the Hueco and the Organ ranges is twenty miles, and along the east face of the latter an abundance of large pine timber is found. From the summit of the table-land the line descends along the plateau to the Rio Grande, at Molino, passing close under the south base of the Organ mountains. No descent is made to the bottom-lands of the river; as at Molino, the elevated table-lands extend down to the very banks. The descent from the summit of the Mesa to Molino is 161 feet in a distance of three miles, or a descent of 53.7 feet to the mile. At this point the Rio Grande is closely bordered on both sides by table-lands, and descends over rapids for the space of half a mile. The bed and banks of the river are rocky, and there is no doubt but that this place presents greater facilities for bridging than any point to the north within three hundred miles.

The table-lands appear to extend uninterruptedly to the west; but my instructions did not authorize any examination west of the river. Major Emory, the present boundary commissioner, is of opinion that it would be impossible, from difficulties of ground, to connect this point immediately with the table-lands, which extend as far to the west as the Rio Mimbres, and that it will be better to continue the line up the immediate valley of the river, to a point three miles above, and there cross. In either case, the best and only easily practicable approach to the river is made at the town of Molino. By this means the whole range of the Organ mountains is avoided, and the profile which accompanies the map will exhibit the impracticability of reaching Doña Ana, with allowable grades, through this range.

Timber.—Timber is found in this section on the east side of the Guadalupe mountains, upon the immediate line of the road, and along the east face of the Organ mountains, about thirty miles north of it.

The valley of the river Sacramento, which is at an average distance of thirty miles north of the line, between the Guadalupe and the Hueco and Sacramento mountains, is said to contain fine timber of almost every description, but my orders did not justify me in attempting the examination of it.

Stone.—Building material of this kind is very abundant along the line throughout this section, and for its character I again refer to the report of the geologist, Mr. Blake. It will be seen that there is an abundance of excellent building-stone, such as granite and carboniferous limestone. As regards the construction of a railroad, the rocks between the Guadalupe mountains and El Paso are very favorable. There are sandstone, limestone, and granite; and it is probable that artesian wells could be bored with success.

Cost.—In estimating the probable cost of this section, it will be necessary to compare the country with a region as nearly similar in character as possible, through which railroads have been built. The route of the Baltimore and Ohio road seems best to fulfil this condition, and it is therefore adopted for the comparison.

It is to be remarked, however, that although the country along both routes is mountainous in some places, yet the mountains are quite distinct in their topographical features, and the intervening valleys are wholly different.

The Alleghany mountains, through which the Baltimore and Ohio road has been constructed, are approached over a very rough country, and numerous lofty spurs of the mountains project far into the uneven valleys along which the road has been located. These spurs prevent the location of the road along the faces of the mountains, and must be cut through or turned. In either case the work is heavy, and the route very much lengthened. The mountains of New Mexico, on the contrary, rise abruptly from a table-land comparatively level, and have few spurs projecting from their faces. In the case of the Guadalupe and Hueco Passes, there are absolutely none. The descent along the lower faces of the mountains is very gradual and very uniform, and conducts to table-lands nearly level, which separate the ranges of mountains. Any heavy work in grading is therefore confined to the short lines through the passes. When practicable passes through these mountains can be found, they present facilities for constructing a railroad altogether superior to those attainable in the mountains east of the Mississippi.

The cost of the Baltimore and Ohio road was $56,000 to the mile (about.) Assuming this as a basis, and adding ten per cent. for transportation of material for building, and we have for the cost of the road through this section $61,600 per mile, and a total cost of $10,400,000 (nearly.)

Labor can be procured on this section much cheaper than it can in any part of the United States, the wages in New Mexico for common laborers being very much below the charges in this country.

RECAPITULATION.

For the First Section.—1st. An air-line; 2d. All requisites for construction; 3d. A maximum grade of 66.2 feet for six miles; 4th. An average grade of 20 feet to the mile for the remainder.

For the Second Section.—1st. An air-line; 2d. Maximum grade of 18 feet to the mile; 3d. The whole line perfectly uniform; 4th. No wood nor water.

For the Third Section.—1st. A maximum grade of 108 feet to the mile for three miles; 2d. A grade of 79 feet (about) for 32 miles; 3d. An average grade of 20 feet for the remainder; 4th. Water sufficient, and timber not remote from the line.

Cost.

Section.	Length in miles.	Cost to the mile.	Total cost.
First	352	$50,000	$17,600,000
Second	125	40,000	5,000,000
Third	169	61,600	10,400,000
Total			33,000,000
To which add cost of line along Red river to Fulton (making total distance from Fulton 779 miles)			7,000,000
Total cost			40,000,000

I have preferred, in making these estimates of the probable cost of the road, to err on the side of excess rather than deficiency, and I am fully satisfied that the estimated amount will entirely cover every possible contingency which may arise under proper management.

The question of the time necessary for the construction of a railroad over this route is surrounded with so many uncertainties, and embarrassed with so many considerations which it was impossible to estimate, that it cannot be expected that I can give even an approximation to the probable period required for the completion of the road.

It will suffice to say that the work can be prosecuted during the whole year, as the seasons are not severe enough to offer any impediment.

I cannot properly dismiss this portion of my report without inviting the attention of the department to two points, which seem to me of much consequence.

I would suggest, in the first place, an early examination of two additional lines from the Pecos, at the 32d parallel, to the Rio Grande, at El Paso. One route diverges to the north, and passing the Guadalupe mountains by the valley of the Sacramento, about thirty miles north of the 32d parallel, unites with the line already surveyed in the vicinity of the Cornudos. It is altogether probable that easier grades could be obtained through the Guadalupe mountains, and the road, although lengthened at least forty miles, would for a portion of the distance traverse the timbered valley of the Sacramento river.

The other line is much more advantageous. It diverges to the south, and turning the Guadalupe and Hueco mountains at their southern extremities, conducts to the Rio Grande, at Molino.

I was informed at El Paso that a route had been hastily examined by intelligent persons in this direction, and that it was more practicable than the present travelled road. The only difficulty that was encountered was the want of water, but it is altogether probable that it could be found by careful examination of the country. This proposed line would probably be

shorter than the one surveyed; and if the ranges of the Guadalupe and Hueco mountains can be avoided, the route would unquestionably be in all respects more favorable.

These routes I consider it of consequence to explore, and I respectfully invite the attention of the department to the propriety of doing so as early as possible in the spring.

It is also, as it seems to me, desirable to make a reconnaissance of the route from the crossing of the Brazos in a direct line to the Red river in the vicinity of Fulton. There are many reasons for this change from the route already surveyed, among which may be stated that the heavy work in the Upper Cross Timbers would probably be avoided, and that a more practicable crossing of Red river could be found.

With a view to the continuation of the line to the eastward, the survey of this route would be in all respects advantageous.

The country in the direct line from Preston to the Mississippi is very much broken, and very rough through the range of the Ozark mountains, which would be completely turned at the south by the route to Fulton. At this place, also, many lines of railroad, from different points on the Mississippi, are rapidly concentrating, and would perfect the connexion with the eastward without the heavy work and enormous expense of continuing in a direct line the route already surveyed.

It would probably be only necessary to make a rapid reconnaissance of this line for the purpose of fixing the positions and determining the character of the crossing places of the Trinity and its tributaries. It is well known that the country would offer no serious obstacle to the construction of a railroad.

To the tables which accompany this chapter I refer for a condensed statement in detail of the ascents and descents to the mile along this route. These are in all cases steeper than it would be either necessary or advisable to establish grades of the railroad. The routes suggested for examination are marked on the map with a dotted blue line.

Table of ascents and descents to the mile from Red river to the Rio Grande.

From Preston, on Red river—	Distance from point to point.	Total distance from Red river.	Ascent, in feet.	Descent, in feet.	Rate of ascent or descent to the mile along the surface line, in feet.
To Mrs. Steele's	5.7	.....	398.2	.....	66.2
Big Mineral	9.2	14.9	40.9	.....	4.5
Lower Cross Timbers	9.3	24.2	135	.....	15
Gainesville	12.5	36.7	96.8	.....	8
Clear fork of Trinity	9.5	46.2	.....	91.2	10.1
Elm fork of Trinity	10.5	56.7	232.6	.....	23.2
East edge of Upper Cross Timbers	8.8	65.5	170.7	.....	19
Lower line of same	4.6	70.1	.....	256.5	51.4
West fork of Trinity	61.3	131.4	.....	12.3	0.3
Brazos river	23.7	153.1	191.9	.....	8
Clear fork of Brazos	32.4	187.5	402.1	.....	12.6
Double Mountain fork of Brazos	90	277.5	1,755.8	.....	19.5
Divide of Brazos and Colorado	7.8	285.3	361.3	.....	45.2
Colorado river	22.8	308.1	.....	278.6	13.3
Sulphur springs of Colorado	44	352.1	319.3	.....	6.3
Summit of Llano Estacado	89.1	441.2	423.6	.....	4.8
Pecos river	35.6	476.8	.....	659.1	18.3
Head of Delaware creek	30	506.8	102.6	.....	3.5
Summit of Guadalupe Pass	24.4	531.2	1,545	.....	61.8
Ojo del Cuerbo	23	554.2	.....	1,824.3	79.3
Los Cornudos	24.1	578.3	478.6	.....	23.8
Los Alamos	8.2	586.5	207.4	.....	26
East edge of Hueco Pass	20.4	606.9	16.7	.....	0.9
Summit of Hueco Pass	1.7	608.6	227.1	.....	57
West edge of Hueco Pass	3.8	612.4	.....	876.6	79.8
Hueco Tanks	2.7	615.1	.....	.....	.....
Summit of Mesa	22.2	637.3	56.5	.....	2.3
Molino del Norte	3	639.3	.....	161	53.6

CHAPTER VIII.

General Summary.—Business of the Road, &c.

I have set forth at some length, though, I fear, imperfectly, in the preceding chapters, the advantages presented by the route I have surveyed for the location and construction of a railroad, and which may be summed up as follows, viz:

1st. That easy grades can be obtained along the whole route.

2d. That the cost of construction is reasonable.

3d. That over more than half the distance timber and building material of every description can be procured on the ground.

4th. That several points are presented on the line not far distant from the heads of navigation of the streams of Texas.

5th. That the only obstacle to an abundant supply of water is easily removed.

6th. That over the most unfavorable portion of the route the grades are not difficult, and timber for the ties is to be transported but short distances.

7th. That the agricultural and mineral resources of the route are in all respects good.

8th. That the chain of military posts to be established for its protection would, both individually and collectively, combine all the necessary requisites to be considered in the establishment of military posts in the Indian country.

9th. That the country traversed is of mild and genial temperature, and but little subject to the changes of the seasons; and, finally, that the route presents every combination of advantages and facilities, both for railroad and wagon-road, for military purposes or for emigration, that can reasonably be expected west of the valley of the Mississippi.

There is, however, another element which enters into the consideration; and although of little consequence should the government undertake the building of the road, has, nevertheless, been the basis upon which all railroads heretofore constructed in the United States have been projected. I refer to its prospective business.

I do not propose to speculate upon the trade of China and the East Indies, nor even upon the exchange of commodities between the Atlantic and Pacific coasts. I presume such matters are better understood by the entire business community of this country than by myself, and I shall therefore confine my remarks upon the subject to a rapid sketch of the local trade at present existing along the route, and of its prospective increase from the construction of a communication with the markets of which the information is not so general.

I had proposed to furnish with this report statistics exhibiting all the facts connected with this subject for a succession of years, but my time is so limited that it will be impossible to arrange such information in an intelligible form. The brief sketch of the subject which I shall give will, however, serve to attract the attention of those interested, and full information concerning all matters relating to it can be easily obtained.

By far the most important commercial feature of the country west of the frontiers of our settled States is undoubtedly what is known as the "Sante Fé trade"—so called for the reason that until very late years Sante Fé was the only port of entry for all goods coming from the United States, whether sold in New Mexico, or in the States of Chihuahua, Sonora, and Durango.

It is not many years since the Sante Fé trail was regarded as something mysterious and

wonderful; and the wild and reckless trader who wandered across the immense plains of the far west with his small stock of goods, was looked upon in our cities as a creature little less savage and ferocious than the grizzly bear of the Rocky mountains. This strange overland traffic across the trackless prairies, and through hordes of hostile Indians, was prosecuted under difficulties and obstacles which have never before surrounded a trading enterprise; and although neither encouraged nor protected by the authorities of the United States or Mexico, it has increased in value with each successive year.

Up to the period of the occupation of New Mexico by the American forces in 1846, the duties collected upon the goods brought across the plains by these hardy adventurers were exactly what the fancy or the interest of the governor of the Territory might dictate; and his simple dictum was sufficient to increase or depreciate the price of any foreign article brought to the markets of New Mexico.

During the dominion of the famous General Armijo, the tariff upon the Santa Fé trade was greatly simplified by the rule which he adopted of collecting $500 for every wagon-load of goods, no matter of what value were the goods or what size the wagon; and during his memorable reign, the traders were accustomed to halt on the borders of the settlements of New Mexico, and concentrating all their property into as few large wagons as would hold it, they abandoned the remainder until their return. As a matter of course, while the extortion of the governor was so unrestricted, and the cost of transporting cheap as enormous as costly goods, the Santa Fé trade was confined to an exchange of expensive articles of luxury for the gold and silver of the mines, and but few of the inhabitants of the country had either the means or the inclination to avail themselves of the opportunity of engaging in so expensive a traffic.

The purchase of the country by the United States, and the protection extended to the traders, have wonderfully increased the value of this trade, and at this time it will not fall short of $6,000,000 annually.

The expense of transportation is still enormous, amounting to $8 per hundred for goods delivered at Santa Fe, and probably as much more for distributing them to points at which they find a market; and the trade of the United States with New Mexico, Chihuahua, Sonora, and Durango is still confined to articles of luxury, exchanged for gold and silver. It is plain that a trade so restricted, which amounts in annual value to $6,000,000, would be amazingly increased could such facilities for transportation and communication be presented as would enable the trader to throw into the country the most common and cheap of our fabrics, and, of consequence, those most useful to the Mexican, and best adapted to his means of purchase.

It cannot be expected that the valuable agricultural features of these territories can be even partially developed when no market for agricultural products is presented, and where nothing but a resort to the mountains for gold or silver will enable the Mexican to purchase articles which he both covets and requires.

So soon as an exchange of the products peculiar to the country, for the fabrics of the United States, can be established by opening rapid and cheap communication by railroad, the Santa Fe and Chihuahua trade will make a commerce which will contribute largely to the support of the road. This trade is now carried on by two routes—one through Texas, and the other from the Missouri river—which unite at El Paso, where the great highway leaves the Rio Grande and conducts south into the northern States of Mexico.

Another element which would enter largely into the consideration of the business of the road, would be the vast impulse given by its construction to the settlement of the fertile region of northern Texas. This vast extent of country is so amazingly fertile and well watered, and so well adapted in climate and character to the culture of cotton, that it is doubtful whether the crops of this region will not, by the construction of a railroad, be the most important element in the wealth of Texas. That a population would assemble along the road more rapidly than it could be built, is rendered more than certain by the very remarkable agricultural resources of the country; and as the line of this road would monopolize the trade of the

fertile valleys of the rivers of Texas, both above and below, it seems not unreasonable to anticipate from this source a very large increase to the business of the railroad.

The emigration to California and New Mexico would not only concentrate necessarily upon the route, and contribute largely to its profits, but would tend, in a remarkable degree, to develop the stock-raising advantages of New Mexico and western Texas. By pursuing this route the emigrant would overcome eight hundred miles of distance, over the worst portion of his route to California, and a journey of two months would be reduced in time to as many days. He would find himself in the valley of the Rio Grande, where stock of all kinds is cheaper than at the points from which he started, and where wagons, provisions, and every necessary could be readily and cheaply supplied, should the demand be sufficient to encourage the production of such articles. From thence he would have a journey to California with wagons of only eight hundred miles, and through a country where severity of climate is unknown. It seems proper to consider this source of profit also as an important element in the business of the road.

These sources of business would undoubtedly build up, at the point where the railroad terminated on the Rio Grande, a populous town, which would be the depot of the immense merchandise to be distributed over New Mexico and the States of Chihuahua, Sonora, and Durango; and as nature has marked unmistakably the point at which the road must approach and cross the river at Molino, this point will undoubtedly add another instance to the rapid growth of cities in the West.

The government annually expends very large sums for transporting troops and supplies to the frontier posts of Texas, and to the military department of New Mexico, which expenditures, although considerably reduced by the less expensive charges on a railroad, could also be fairly exhibited as a prospective source of profit.

I have neither the time nor the means at present to enter into detailed estimates of the value of the business accumulated from the sources to which I have referred; but I am of opinion that examination of the subject will fully justify the belief of which I am fully possessed, that a railroad across northern Texas will be profitable, even if not continued beyond El Paso.

It seems proper also that I should refer in this place to the eastern terminus of this survey, to which there are some objections as a terminus to a railroad which looks to a connexion with the East.

The Red river from Preston to Fulton, in Arkansas, has a direction very nearly east, and I would suggest as forcibly as possible the continuation of this line in the direction of the latter point. The dividing ridge between the waters of the Trinity and Red rivers is in all respects of extreme practicability for the construction of a railroad, and the eastern terminus would be thrown forward to a point where a series of railroads from every direction is rapidly concentrating. By this extension, also, the range of the Ozark mountains, which interpose in the direct line between Preston and Little Rock, or Memphis, is completely turned at its southern extremity, and the surveys of the route from Little Rock to Fulton, which had just been completed when I reached the frontier of Arkansas, exhibited a route entirely favorable. It would not be necessary to continue the examination of the route from Preston to Fulton, as the character of the country and its practicability are well known.

In the consideration of a proposed eastern terminus of the Pacific railroad it has been urged, as a point of much consequence, that it should be so placed as to insure the earliest and most favorable connexion with the lines of railroad at present built, or in process of construction; and it therefore seems proper that I should exhibit what advantages of the kind are offered by the route now in question. Fulton, in Arkansas, its proposed eastern terminus, is the centre to which many lines of railroad are now concentrating, and which will undoubtedly be finished as soon as the terminus of the Pacific railroad shall be established, and long before the road can be built.

From Cairo, at the mouth of the Ohio, where it connects with the great Central road of Illi-

nois, a railroad is now in process of location and construction through Little Rock to Fulton. At Little Rock it is met by a branch from Memphis. A road from Vicksburg and the New Orleans and Shreveport road, along Red river, unite at Fulton; and these various lines connect at their eastern termini with the great chains of railroad which traverse nearly all the States of the Union. In this respect, therefore, this route seems to combine all the requisites or recommendations which seem desirable.

But there is one element, of a consequence not to be overlooked in estimating the advantages of this route; and that is, the means now at hand without the aid of the government for building it.

The State of Texas has granted something more than ten millions of acres of land to any company which will undertake, under sufficient guarantees, to build a railroad along this route as far as the Rio Grande. The company have the privilege of selecting the lands thus granted from any unoccupied lands in the State; and to one who understands the value of the arable lands in Texas this grant seems altogether sufficient for the construction of the railroad. There can be no doubt, if the company which undertakes its construction can, upon this basis of real estate, borrow the funds necessary to complete the road before they are compelled to offer the lands for sale, that the grant will not only be sufficient to pay the cost of the road, but will make this company the richest corporation in America.

By this munificent contribution of Texas in aid of a great national enterprise, the question of the Pacific railroad is reduced from the consideration of a line of 2,000 miles to one of 800 miles; and to dwell upon the importance of this fact seems alogether superfluous.

I am, sir, respectfully, your obedient servant,

JNO. POPE,
Brevet Captain Top. Engs., in charge of Exploration.

Hon. JEFFERSON DAVIS,
Secretary of War.

APPENDIX A.

DIARY OF THE EXPEDITION.

BY J. H. BYRNE, ASSISTANT COMPUTER.

CHAPTER I.—*From the Rio Grande, at El Paso, to the Pecos, at the 32d parallel.*

The surveying party arrived at Doña Ana from Albuquerque on the 16th January, 1854. In consequence of the judicious measures taken, the journey across the "Jornada del Muerto" was accomplished without any suffering either to men or animals. The latter were in good condition when they reached Doña Ana.

It had been anticipated that a delay of not more than ten or twelve days would be necessary to complete the arrangements requisite for the movement of the expedition. These anticipations, however, proved fallacious. Orders had been issued that the transportation for the escort should be supplied from El Paso; the wagons and teams to be taken from the train that had transported the four companies of the 8th infantry from Texas.

On making application to Brevet Lieut. Col. Alexander, who had the control of these wagons, &c., an unlooked for difficulty arose, which caused an embarrassing and *expensive* delay of four weeks. Col. Alexander declined to supply the transportation, stating that he had no authority to turn it over on the requisition made upon him. After many fruitless efforts to change this opinion of the Colonel's, it was determined to send a *special express* to the headquarters of the department, at Albuquerque, for such orders as would set the matter at rest. The express was accordingly despatched, with directions to make the trip to headquarters and back in eight days: it returned within the time agreed upon. The orders brought by it were immediately forwarded to Col. Alexander, who at once furnished the transportation.

During this detention, the valley of the Mesilla was surveyed and sketched; and every information of a scientific character, tending to illustrate the natural productions of this section of country, was obtained. It is not necessary in this place to describe Doña Ana or its neighborhood; it has been so often and so well depicted, that any notice of it is rendered totally superfluous.

Every obstacle being now happily removed, the transportation for the escort arrived from El Paso on Friday, the 10th of February, 1854. It comprised eight wagons with six mules each, and one extra team of six mules, under the direction of wagonmaster W. B. Beylor. This party brought with them from Fort Fillmore sixteen beeves and seventy head of sheep. The most energetic exertions were *at once* made to forward the final preparations. The next day, the 11th, was devoted to loading the wagons, repairs, &c., &c.

While remaining here, all the animals were turned out to graze from sunrise to sunset. We hauled our wood from the vicinity with our own wagons.

Starting.—All being in readiness, the expedition left Doña Ana at 9 o'clock a. m. on Sunday, 12th February, 1854. The party consisted of Captain John Pope, topographical engineers

United States army, commanding; Lieutenant K. Garrard, 1st dragoons, assistant engineer; ——— ———, quartermaster and commissary of subsistence; Lieutenant L. H. Marshall, 3d infantry, commanding escort; Captain C. S. Taplin, acting mineralogist; Dr. W. S. Diffendorfer, surgeon and acting naturalist; John H. Byrne, computer; Thomas Mitchell, wagon-master; escort (twenty-five rank and file,) teamsters, herders—numbering in all seventy-five persons. The party found it impossible to obtain a guide, or to collect any information in reference to our route, not one of the persons spoken to on the subject having ever traversed it. Neither could a forge be obtained. The want of this indispensable article was severely felt.

Camp No. 1—*Sunday, February* 12, 1854.—The command moved east from Doña Ana over a road of about six miles deep sand; the remaining portion of it (seven miles) was good, with a gradual ascent for about ten miles before we reached the pass in the mountains. The road at this point is rocky, with an abrupt rise. The cold was here intense, although in the valley beneath it was comparatively warm. Descended the mountain for about five miles, having the Organ peaks on our right hand, and encamped at San Augustin springs at 5 p. m. Water plenty; wood scarce; grama-grass good, and in abundance. The mules were here hobbled and turned out to graze during the night, having been previously fed with corn. Captain Pope accompanied the command four miles from Doña Ana, and then took the road to El Paso, "to transact some business and make some necessary surveys." General direction, north 81° east; miles, $18\frac{9}{10}$.

Camp No. 2—*Monday, February* 13, 1854.—Animals driven in to the wagons and fed with corn at daylight. Command started at sunrise; road good. Arrived at the Ojo de la Soledad about noon. The wagons were here unhitched and the animals watered. The water is one and a half mile to the right of the road. In consequence of the uneven and rocky nature of the ground, wagons cannot reach it. The water is situated in a rocky ravine. The command halted here for the remainder of the day. In anticipation of crossing the Jornada to the Hueco mountains, the water-barrels were filled. This consumed much time, and cost a great deal of labor, the water being at so great a distance, and so difficult of access. The animals were hobbled and turned out to graze until sundown, when they were driven in and fed with corn, after which they were herded and grazed during the night. Grama-grass good and plenty. General direction, south 53° east; miles $8\frac{1}{2\,0}$.

Camp No. 3—*Tuesday, February* 14, 1854.—Animals driven in at daybreak and fed. Command moved about sunrise. The road for upwards of seven miles was rocky and uneven; the remainder through pretty deep sand. One wagon broke down during the day: it had to be brought along on a slide. This accident occasioned a considerable delay. Two white mules strayed away—supposed they went after water. Two of the Mexican herders were sent in search of them. Encamped at sundown on the Jornada. No water nor wood; grass plenty. Cooked with the brush that lay around upon the plain, sufficient for the purpose. As the animals evinced signs of fatigue, they received an additional allowance of corn; afterwards they were hobbled, turned out to graze, and herded, as usual, during the night; which was very cold, with a high wind. General direction, south 49° east; miles, $13\frac{9}{10}$.

Camp No. 4—*Wednesday, February* 15, 1854.—Animals driven in and fed before daybreak. Command started a little before sunrise. It was hoped we would be able to reach the Hueco Tanks before night. Lieutenant Marshall and Captain Taplin left the party in the early part of the forenoon to find the trail. The road was over heavy sand; several ridges of sand had to be crossed. Having followed the road for about eight miles, we turned off to the left in the direction of the Tanks. Nooned for two hours; animals turned out to graze. As we had now to make our own road through deep sand and brush, our advance was slow. Having made about twelve miles, the animals showed such symptoms of exhaustion that it was deemed advisable to lighten the wagons. One hundred and twenty-five fanegas of corn were accordingly taken out and left on the prairie. This was about 4 o'clock p. m. We travelled until nearly 11 o'clock p. m.; but, in the darkness, getting entangled in some sand-hills, we were obliged to halt for

the night. The animals were here fed with corn; but as they had been for *sixty hours* without water, they did not eat. All eyes were turned in the *supposed* direction of the Hueco Tanks, hoping to discern a light to serve as a guide, but in vain. Neither Lieutenant Marshall nor Captain Taplin had joined the command up to this hour. Wagonmaster Beylor started on horseback to find the Tanks. He returned long after midnight unsuccessful. Animals turned out to graze as usual. No wood; no water; grass plenty. General direction same as yesterday; miles, $17\frac{4}{10}$.

Same Camp—Thursday, February 16, 1854.—At sunrise principal wagonmaster Mitchell, accompanied by a soldier, (who stated he knew where the Tanks were situated,) left camp to find them. During their absence, Lieutenant Marshall and Captain Taplin came into camp about 9 o'clock a. m. They had found a trail, and reached the Hueco Tanks on the previous night, but had no means of communicating with us. We found we had camped upwards of six miles to the west of them. All the animals were immediately driven to water. As they had now been seventy-two hours without it, they quickly exhausted the tanks on the west side of the mountain. That upon the east, however, afforded an ample supply. It was intended to move the camp this day, but the unavoidable delay in watering the mules and stock prevented this intention from being carried into effect. An ambulance with six kegs brought sufficient water back to camp for cooking until the next day. The animals were fed, hobbled, and turned out to graze during the night.

Camp No. 5—*Friday, February* 17, 1854.—Left camp about 8 o'clock a. m., and moved to the Hueco mountains, which we reached about 11 o'clock a. m. These mountains are composed of a dark gray sandstone, scattered about in high masses in the most grotesque disorder and confusion. The tanks containing the water are immense reservoirs, hollowed out by the hand of nature. That upon the west side is capable of holding about five hundred gallons; the other, upon the east side, would contain, when full, perhaps fifteen hundred gallons. The animals were watered, hobbled, and turned out to graze. General direction, south 62° east; miles, $6\frac{8}{10}$.

Same Camp—Saturday, February 18, 1854.—On examination many of the wagon-wheels were found to require repairs; they were taken off the wagons and sent to El Paso to have the necessary repairs made. The want of a forge, already alluded to, was now sensibly felt. Lieutenant Garrard left for the same place on business. Wagonmaster Beylor, with seven wagons, returned for the corn that had been left on the Jornada, (see Wednesday, 15th instant,) and arrived in camp with all the corn about 8 o'clock p. m. same day, having made twenty-eight miles. About the same hour the Mexicans, who had been sent after the stray mules, (see Tuesday, 14th,) came into camp, bringing the animals with them. They say that, with the exception of a small quantity of bread, they have subsisted for four days upon a hawk which they shot; they had to follow the mules to Camp No. 2, "Ojo de la Soledad," where they had to rest the animals, which were in a very weak condition. One mule missing; it has gone towards the "Pass," as it can be tracked by the lariat. A Mexican herder sent in pursuit. The animals fed, hobbled, and grazed, as usual. At this camp there is abundance of wood and grama-grass.

Same Camp—Sunday, February 19, 1854.—The mule which strayed from camp (see Saturday, 18th) returned by itself. Besides the water contained in the Tanks, there are numerous holes and crevices in the mountains, which contain sufficient for every purpose to last for a considerable time. It is proper to remark that animals cannot drink from the Tanks; the water is taken out in buckets, and thrown down the rocks until all have been supplied: thus, watering is a matter of time and labor. The peculiar formation of these mountains, their innumerable caverns and hiding-places, seem to have been intended for a refuge for the Indians; nor have they neglected to avail themselves of its advantages. In one instance, however, they "reckoned without their host." About fourteen years ago these Arabs of New Mexico, the Apaches, having made a desperate foray upon the Mexicans, retreated with their plunder to these mountains. The Mexicans surprised and surrounded them, hemming them up in the rocky ravine forming

the eastern Tank. Here an engagement took place, in which the Indians were totally defeated and nearly exterminated, only two or three escaping. It is said that upwards of one hundred of them were killed. The water in the Tank is rapidly diminishing. At the present rate of consumption, it cannot be calculated on longer than three or four days more; but there is a sufficient quantity of it in the numerous holes in the mountains to supply the command for cooking purposes for a considerable time longer. The animals fed, hobbled, and grazed, as usual.

Although the command has traversed through the very centre of the Indian country, we have not up to this time seen an Indian. It is a matter worthy of remark that not one animal has been lost. This happy result proceeds, no doubt, from the unceasing vigilance and care with which the animals have been watched. A strong guard is posted every night from sundown to sunrise. To prevent any loss by a "stampede," the precaution has been taken to hobble the animals whilst out grazing.

Same Camp—Monday, February 20, 1854.—The Mexican sent in pursuit of the stray mule (see Saturday, 18th) arrived in camp. The men in camp were this day occupied in repairing harness, wagons, &c., &c. The animals since our arrival at this camp have not been turned out to graze at night. They are herded all day until sundown; then driven in, fed with corn, and tied to the wagons. This arrangement is considered a matter of necessity, and is adopted to prevent any loss. The weather continues warm and pleasant in the day-time; the nights are a little frosty; indeed, the only inconvenience felt in this respect is from the wind, which frequently sweeps through the cañon with great violence. Water nearly exhausted.

Same Camp—Tuesday, February 21, 1854.—The teamsters still occupied in making repairs, &c. On examination it was found that the water will not hold out longer than to-morrow. The wagons, which carried the wheels requiring repairs to El Paso, returned. Captain Pope, Lieutenant Garrard, and the party which accompanied them, joined the command about 9 o'clock p. m. A man named Cutting, who had been sick for some time at Fort Fillmore, returned with them. He had been attacked at Doña Ana with pleurisy, and sent to the above post for medical treatment. All the water-kegs filled, and carried to the next camp.

Camp No. 6—*Wednesday, February* 22, 1854.—Left camp at 2 o'clock p. m., and moved in the direction of the Cerro Alto. The road winds through a deep ravine; it is a good gravelly road. Reached the Cerro Alto at 5 o'clock p. m., where we camped. No water; grama-grass good and abundant. No wood; a sufficient quantity of brush was found for cooking purposes. Observations made at night for the latitude. On our arrival in camp the animals were turned out to graze for a short time; then brought in, fed with corn, hobbled, and grazed during the night. A strong guard was posted. It froze pretty hard during the night, with a strong wind. General direction, north 30° east; miles, $4\frac{2}{10}$.

Camp No. 7—*Thursday, February* 23, 1854.—Left camp about sunrise, and moved in the direction of the Sierra de los Alamos. From this camp there are two roads leading to them. One runs south of the Cerro Alto, and is much shorter than the road we took. It is formed by the dry bed of a creek, and is tolerably good; but at one point it has a descent so steep and abrupt, that it was deemed more safe and prudent to take the longer and more beaten track. The latter (surveyed by Colonel Johnston) runs, for about two miles from our last camp, through a deep and tortuous cañon; the road here is rocky. By doubling teams on some of the wagons we surmounted three very steep hills, at the first of which one of our wagons broke down. It was broken up, and such portions as were thought useful, in view of future accident, were put into the other wagons and carried along; the remainder was abandoned, as we had no means at our disposal for repairing it. On leaving the cañon we came upon a good gravel road, nearly level, with the exception of some gentle undulations of the ground. Our camp for the approaching night (Los Alamos) could be seen during the whole day. We reached it, and encamped at $5\frac{1}{2}$ p. m. The Sierra de los Alamos consists of three mountains, directly to the east of the Cerro Alto. The water is situated on the north face of the mountain, about half a mile from the road. There is a trail leading to it. Indeed, it cannot be mistaken, as there are a few cotton-wood

trees near the springs, and nowhere else in the vicinity. The water is difficult of access. It issues from seven holes, and is supplied from springs in the rocks; there was sufficient for every purpose. Good grass; no wood; brush around camp for cooking. The animals having been watered, were fed with corn, and tied to the wagons until 2 o'clock a. m., when they were hobbled and turned out to graze until after sunrise. Observations for the time were made during the day. A strong guard posted as usual. General direction, north 70° east; miles, $20\frac{8}{10}$.

Camp No. 8—*Friday, February* 24, 1854.—Left camp at 9 o'clock a. m., moving in the direction of the Cornudos mountain. There is a fine gravelly road from our last camp to this mountain; there are some hills in the course of it, but they do not present any difficulty. We reached our camp, the Cornudos, about 2 o'clock p. m. This mountain is about five hundred feet high, and consists of huge masses of rock scattered in the utmost disorder and confusion. The water (as at the Huecos) is contained in reservoirs in the rock, and is very difficult to reach. There was sufficient for all purposes. Grass good; wood plenty. On the east of the mountain there is a cavern, entered by an arched doorway, receiving light through an opening in the roof, in which there was a well (now filled with sand) which, it is said, at one time contained twelve feet of water. There are also many other places here equally curious and interesting. The geological formation of these rocks differs from those of the Huecos, as they consist of a kind of granite or gneiss. The weather was colder this day than we had experienced since we left Doña Ana. The animals, immediately on our arrival in camp, were watered, hobbled, and turned out to graze, having been first fed with corn. As usual, a strong guard was posted during the night. Observations for the time were made during the day, and also at night for the latitude, but without satisfactory results, as the night clouded up. As we could not reach water on the next day's march, the casks were all filled. Although a great quantity had been used from the reservoirs, there did not appear to be any diminution of the water in them. A little rain came down about 4 o'clock p. m. General direction, north 45° east; miles, 9.

Camp No. 9—*Saturday, February* 25, 1854.—Left camp at 11 o'clock a. m. The mules and stock were allowed to graze until 10 o'clock a. m., when they were all watered. Before leaving camp some requisite repairs were done to the wagons. The road for this day was good, over a gravelly mesa. Reached camp, open prairie, at $3\frac{1}{4}$ p. m. No water; no wood; brush enough for cooking purposes; grama-grass good and abundant. The animals were hobbled and turned out to graze till sundown, when they were driven in and fed with corn, then turned out to graze for the night; a strong guard posted as usual. Up to this time we have not seen an Indian; still, every precaution that prudence can dictate is taken to prevent surprise. We have not lost a single animal as yet. General direction, south 85° east; miles, 12.

Camp No. 10—*Sunday, February* 26, 1854.—Left last camp at twenty minutes after 7 o'clock a. m., and moved to our next camp, the Ojo del Cuerbo. Our road for this day was good; for about six miles it was gravel; the remainder a firm red soil, until we approached within a mile and a half of camp, when it became somewhat sandy. At about eight miles from camp we came to a gradual descent, which continued until we reached the bed of the Salt lakes, about one and a half mile west of the Ojo del Cuerbo. Encamped ten minutes past 2 o'clock p. m. The mules travelled very well to-day, and are in very good condition. The Ojo del Cuerbo consists of two sulphurous lakes. The surface of this valley is covered with a salty and sulphurous efflorescence, which continues in a southerly direction until it reaches the Pecos, at a point where it is joined by the Lymphia, a distance of nearly two hundred miles. The valley around our camp, as far as the eye can reach, is dotted with patches, of considerable magnitude, of a brilliant whiteness; they are deposites of pure salt, formed by the evaporation of the water. Many holes had been dug near our camp, the water in which does not taste very salty; it loses much of the salt while filtering through the sand from the lakes. The grass is strongly impregnated with salt, and cannot be nutritious. No wood; brush very scarce. Found here, for the first time, *bois de vache*. On our arrival at camp the animals were watered, hobbled,

and turned out to graze; they were afterwards (at sunset) driven in, fed with corn, and tied to the wagons until daybreak, when they were turned out to graze until 9 o'clock a. m., when they were well watered. As we did not anticipate reaching water the next day's march, the kegs were filled, for the use of the command, from the holes already mentioned. Observations for the time were made during the day. As the Ojo del Cuerbo is considered a dangerous camping-ground, all were upon the *qui vive;* and, as a precaution against a stampede, the mules were tied during the night to the wagons. A strong guard posted. General direction, north 82° east; miles, $17\frac{1}{10}$.

Camp No. 11—*Monday, February* 27, 1854.—Left last camp at half-past 9 o'clock a. m. Our course for this day was, for about seven miles, through deep and heavy sand, along the base of a range of low and very white sand-hills; the remainder of the march was over a good gravelly road. From many of the heights in the road we could see the Salt valley stretching away to the southward, as far as the eye could reach. The left side of the road, for some distance from camp, was dotted with small sand-hills of dazzling whiteness. Reached our encampment on the prairie at ten minutes to 3 o'clock p. m. The animals were immediately hobbled and turned out to graze until sundown, when they were driven in, fed with corn, and grazed until sunrise. No water, nor wood; brush sufficient for cooking purposes. Grama-grass good and abundant. As we approach nearer to the Guadalupe mountains, (supposed to be the most dangerous part of the road,) our vigilance is redoubled. General direction, south 60° east; miles, $12\frac{4}{10}$.

Camp No. 12—*Tuesday, February* 28, 1854.—Left last camp at half-past 7 o'clock a. m., and moved for the pass of the Guadalupe mountains. Our road to-day was bad and rocky. We had to pass over some steep hills of the same character. Our course lay south fifty degrees east for about seven miles, then turned north sixty-eight degrees east for upwards of three miles, then for about one mile north forty-eight degrees east. Before entering the cañon we avoided a steep and difficult hill, by making a detour to the left of the road, striking at a short distance the beaten track. We now entered the cañon, and encamped about half way up it, on a small and rocky plateau, at twenty minutes after 4 o'clock p. m. The passage through the cañon is along the dry bed of a stream, which has its source near the high peak of the Guadalupe mountains, and is very rough and difficult to travel. One wagon broke down here, which we abandoned, having no means of repairing it. Springs are found at the head of the ravine under the highest peak, and about five hundred yards from the point at which the road ascends the face of the bluff. We found plenty of wood (mezquite and brush) to answer all purposes. The south peak rises in a bold outline, towering to the enormous height of two thousand feet; it is composed of gray sandstone. The animals were watered, fed with corn, and turned out to graze during the night. Grama-grass poor, and very scanty. Observations for the time were made during the day, and also at night for the latitude: the latter were not very satisfactory, as the northern stars clouded up. Miles, $18\frac{8}{10}$.

Camp No. 13—*Wednesday, March* 1, 1854.—Left camp at $8\frac{1}{2}$ a. m. We moved up the cañon, breasting a steep and rocky ascent; there is an abrupt turn to the right, which we were obliged to take, which led us up a continuation of this hill for about a quarter of a mile before we reached the summit. This task consumed considerable time, but it was accomplished without doubling teams, or any accident occurring. From the summit the view over the surrounding country was at once grand and picturesque—the southern peak of the Guadalupe towering majestically above all.

Our march, until we reached the "Pinery," (our camp,) was over a good gravelly road. We arrived here at half-past 11 o'clock a. m. There is an abundance of everything requisite for camping at this place. The water (springs) is situated at the distance of five hundred yards from the road, at the base of the mountain; timber and good grama-grass are plenty. We were fortunate in obtaining a fine specimen of the "maguey" plant, the first we had yet seen; it was earthed in a box and carried along. This encampment is by far the best we have yet

come to. On our arrival the animals were hobbled and turned out to graze until sundown, when they were driven in, fed with corn, and tied to the wagons till sunrise, when they were grazed a couple of hours before starting. As we are now in a dangerous locality, the animals are tied to the wagons as a prudent precaution. Observations for the time taken during the day, and for the latitude at night: the latter had to be discontinued, as it blew a perfect hurricane from about 4 o'clock p. m. until we left camp next morning. The night was excessively cold and severe. A strong guard posted; while the cattle are grazing (although hobbled) there is a guard placed over them. General direction, south 84° east; north 45° west; miles, $4\frac{1}{10}$.

Camp No. 14—*Thursday, March* 2, 1854.—Left camp at $8\frac{1}{2}$ a. m., and moved in the direction of Independence spring. Our road was a good gravelly one, with a gentle descent from camp to camp. A black-tailed deer was shot, skinned, and stuffed; we were also fortunate in finding some curious specimens of cactus. We reached camp—the above spring—at twenty minutes to 11 o'clock a. m. This is a spring of clear and pure water; it issues from a deep and large hole, through a quicksand bottom, in a rapid stream. Means were taken to sound the depth of this hole, but without effect—a pole of considerable length going down without meeting any obstruction. This spring is no doubt supplied from the mountains in its vicinity. Grama-grass good and abundant. There is here a sufficient quantity of mezquite and brush to answer for cooking purposes. On reaching camp the animals were watered and turned out to graze, being hobbled as usual; brought in at sundown, fed with corn, and tied to the wagons during the night. No observations taken. General direction, 89° east; miles, $6\frac{3}{10}$.

Camp No. 15—*Friday, March* 3, 1854.—Left last camp at 10 minutes past 7 a. m. Our road for this day was over a rolling prairie, and, with the exception of one steep and rocky hill, was, on the whole, pretty good. There are, however, some deep and rocky gullies, worn from the rain descending from the higher ground, which caused some little difficulty. At about twelve miles from last camp we halted for a short interval to rest. The mules travelled well to-day; taking all things into consideration, they are in good condition. Reached our camp, head of Delaware creek, at fourteen minutes to 3 o'clock p. m. About one and a half mile from this camp we crossed the dry bed of a creek. The wagons were halted here, and wood placed in them for the use of the command. There is at this point an abundance of dry and good wood.

Along our line of march to-day we perceived several graves, over which were placed flat stones. No inscription told the names of those who "slept beneath," nor recorded the manner of their death. There is something so melancholy about these resting-places, removed as they are from the habitations of civilized man, that reflections of a serious nature are called up in the minds of the most volatile.

On our arrival at camp the animals were watered, hobbled, and turned out to graze. As it is contemplated to remain here for a couple of days, they were not fed with corn, but were turned out to graze under a strong guard. The grama-grass is good and plenty. Observations for time and latitude taken this day. General direction, 84° east; miles, $16\frac{1}{10}$.

Same Camp—Saturday, March 4, 1854.—Lieutenant Garrard left camp this morning with one wagon, escorted by five soldiers and five men of the train; the former rode in the wagon, the latter were mounted. All were well armed. Lieutenant Garrard's object is to find a more direct route south of the Guadalupe range, and to proceed until he could see the Alamos, one of our former encampments. (See No. 7, Thursday, February 23, 1854.) It was decided that the command would await his return at our present camp. The assistant wagonmaster was sent to hunt up wood at a nearer point than the place we had taken it from the previous day; but he was not successful. On his return, two wagons, under a guard, were ordered to bring wood from the dry creek we passed yesterday.

Our present camp is twenty-six and five-tenths miles from the peak of the Guadalupe mountains, opposite to it and directly east. This camp presents some interesting features. On examination we have found upwards of eight springs, located in a space of about two hundred yards. One of these rushes out in a bold and rapid stream, over a limestone bottom. The

water is pure and good. There are also three more, nearly as good, at a short distance up the creek. Several of them are clustered together at the head of the creek, within the space of a few yards; four of them are strongly impregnated with sulphur, each of them differing in strength; the whole of them (both sulphurous and pure) flow into the creek, forming a most detestable compound. It is not presumptuous to suppose that a careful analysis of these sulphureted springs would develop medicinal properties of a highly important character. A keg of this water is carried along for the use of one of the command, who is afflicted with a painful eruption on the face; its effect will be noted in due time.

We cooked to-day a maguey plant. This plant is extensively cultivated in old Mexico, and a wine called "pulque" extracted from it by tapping. It is said that one plant will yield four quarts of juice a day for four or five months. The Apache—who has not arrived at the degree of civilization necessary to manufacture intoxicating liquors—cooks and eats it; decidedly the most sensible plan. The following is the *modus operandi:* The lower and sound portion of the plant (not the root) is divested of all the leaves, stalk, &c., then placed into a hole dug in the ground, covered completely with earth to the depth of an inch, and over all there is built a good but slow fire. It requires from twelve to eighteen hours to cook it thoroughly; when cooked thus it is extremely pleasant to the taste, and is a capital substitute in the absence of all other vegetables; indeed, it is the only diet of this nature that these Indians possess. The other way of cooking it is to pound or mash it up, and boil it until it becomes thick. This is also very palatable and nutritious.

At a short distance from camp (down the creek) there are large quantities of gypsum in a state of decomposition. We found here a species of pepper-grass, having a sharp and pungent taste. Since our arrival here we have added largely to our collection in natural history, mineralogy, and botany.

The mules have been grazed since our arrival. The principal spring is called the "Ojo de San Martin." Observations for the time taken to-day, and at night for the latitude and longitude. The day warm and pleasant; the night clear and frosty; no wind.

Same Camp—Sunday, March 5, 1854.—The wagon which accompanied Lieutenant Garrard returned with the five soldiers who formed part of the escort. Lieutenant Garrard, with the remaining part of his escort, came into camp at sunset. In pursuance of the arrangement, (already mentioned,) he proceeded south of the Guadalupe range of mountains to find a pass which, it is said, runs in the direction towards the Pecos. This country is a succession of bluffs, rising from the mountains in a gentle ascent, to a point twenty miles below them. Here this description of country terminates, and it becomes totally impassable—the descent as far as the Salt lake being rocky and precipitous. There is no such pass as that stated by Captain Marcy and Colonel Grey. The wagon had to be sent back, as it was found it could not proceed farther than the point above indicated. Through the negligence of the man who carried the theodolite, it was seriously injured. This man's pay was stopped, and he was ordered to work with the teams for his rations. In consequence of this serious accident, the whole command was cautioned, and told that a similar punishment would be inflicted upon any who would perform the duties assigned them in a careless or heedless manner. The soil around our camp is deeply impregnated with sulphur. No observations taken; the sky clouded during the day and night. The animals were turned in at sunset, and fed with corn; afterwards grazed during the night, being, as usual, under a strong guard, and hobbled.

Camp No. 16—*Monday, March* 6, 1854.—Left last camp at half-past 8 o'clock a. m. Our road for this day was a good gravelly one, with a gentle descent for the whole way. We had some few hills, but they presented little difficulty. The principal wagonmaster, with three men, started at daylight this morning to follow the course of the Delaware creek, and find a practicable road for a wagon to the Pecos. The soil we passed over to-day is composed of sand and gravel, mixed with gypsum. Many curious botanic specimens were this day obtained.

Our camp, which we reached at 3 o'clock p. m., is about half a mile to the right of the road,

on the Delaware creek. There is much difficulty in watering animals at this stream, the greatest care being required to prevent them from miring. The water flows through a deep basin about six hundred yards from camp, which is deeply strewed over with gypsum.

The day was remarkably warm, sultry, and cloudy, giving some indications of rain. At night it rained heavily for a short time, with flashes of very vivid lightning, accompanied by loud thunder, which could be heard reverberating through the mountains we had left behind us.

The grama-grass is good; wood, consisting of mezquite, cedar, and brush, is plenty. The animals were brought in from grazing and fed with corn; then turned out to graze for the night. Reached camp at 3 o'clock p. m.; general direction, north 38° east; miles, $12\frac{2}{10}$.

Camp No. 17—*Tuesday, March* 17, 1854.—Left last camp at twenty minutes after 9 o'clock a. m. At a short distance from camp we met the wagonmaster and party, who reported, "that by following the creek on its left bank we would have a good road to the Pecos." Reached the "crossing of the Delaware creek" at 2 o'clock p. m., where we halted; the animals were watered and allowed to graze for a short time. We did not cross the creek, but continued down the left bank; in this we did not experience any difficulty. The country is an open and nearly level prairie, having a slight descent (nearly the whole way) towards the Pecos. We have now to make our own road. At about ten miles from last camp, the nature of the soil changes; the gypsum disappears. From this point to the river the soil is light sand mixed with gravel, producing an abundance of excellent grama-grass. From the crossing of the Delaware to the Pecos there is no growth of wood of any description whatever; we found, however, along our line of march, plenty of mezquite root, dry and good.

About a mile from our halting-place, (the crossing,) and on the opposite or right bank of the creek, there is a valley of about eight hundred acres of good soil, which could be irrigated from the creek at no very great cost of labor or money. The want of timber, and the difficulty of irrigating the land, will no doubt prevent this section of country from being cultivated to any great extent. The last obstacle might be surmounted, but the former appears irremediable.

Along our road to-day we discovered several caves. On examination they proved to be highly interesting, their interior being composed of gypsum, the roofs and sides highly polished, and of the purest white: they well repay the trouble (no easy matter) of entering them.

We reached our camp at half-past three o'clock p. m., situated on the creek. Here there is an abundance of good grama-grass. The mezquite wood is plenty, and can be obtained without much labor. We killed a rattle-snake (the first we have yet seen) on a hill near camp. It was put in spirits and carried along.

The wagonmaster, on his return, (as above mentioned,) reports that at the Pecos he discovered a fire—still burning—at which some Indians had been cooking. From their tracks they were on foot, and appeared to have crossed the river. This was near the mouth of the Delaware creek, our proposed camp for to-morrow night. There is a plenty of wild ducks and hens on the creek. On arriving at camp the animals were turned out to graze, hobbled as usual; brought in at sunset, and fed with corn; then turned out to graze during the night under a strong guard. No observations made. General direction, north 50° east; miles, $13\frac{9}{10}$.

CHAPTER II.—*From the Valley of the Pecos to the Sulphur Springs of the Rio Colorado of Texas.*

Camp No. 18—*Falls of the Rio Pecos, mouth of Delaware creek, Wednesday, March* 8, 1854.—Left last camp at twenty minutes after 7 o'clock a. m. Our road to-day was through an open and nearly level prairie, similar to that we travelled yesterday. The soil is good; gravel and sand. In all directions on our line of march there is an abundance of mezquite root, but, as before mentioned, no growth of wood. We reached our camp, Falls of the Rio Pecos, mouth of Delaware creek, at five minutes to 10 o'clock a. m. We were fortunate enough at this point to discover an excellent crossing, about one hundred yards from the mouth of the Delaware

creek. The water rushes over "falls," in a bold and rapid current, at a rate of nine knots per hour. The river at this point has a good rocky bottom; is about eighty feet wide, and two and a half feet deep. There are here seven little islands, through which the stream flows with great force. This crossing presents no difficulties whatever, only requiring a few hours' labor to cut down the banks on either side, to permit wagons *heavily loaded* to cross over without trouble. Those who are well acquainted with the several crossings of the Pecos below this say that it is by far the best along the river. The animals were hobbled and turned out to graze. The grama-grass is good and abundant. Sufficient mezquite around camp for cooking purposes. The water is brackish, but not to such a degree as to affect the health. General direction, north 42° east; miles, 6.

Same Camp—Thursday, March 9, 1854.—The soil of the valley, on examination, proves to be fertile and of easy cultivation. It can be irrigated from many points of the river. All the way up it, as far as we have gone, it is rapid, and varies from five to twenty feet in depth. Its waters are discolored, and abound in catfish of a very large size. There are also, though not plenty, some wild duck and water-hen along the banks.

The valley of the Pecos is about two and a half miles in width, enclosed by gently receding table-lands, and, although nearly destitute of timber, yet supplies an abundance of mezquite root for fuel. The surface of the table-lands and ridges present only the dwarf mezquite brush, but beneath the whole earth is a network of the root, in some instances as large round as a man's leg, and furnishing the best fuel known to the country. The town of El Paso and its vicinity are supplied entirely in this way. The Pecos traverses its valley in a very tortuous course, and with a current of about two and a half miles to the hour, and from five to twenty feet depth of water. In many places bluff banks of diluvium and gypsum, about fifty feet high, impinge upon its banks. The river below the 32d parallel changes its character from a rocky bed, with occasional rapids, to soft mud bottom and banks. Fording-places below this paralle are very rare, and present in all cases a depth of water which, at any other than the dry season, absolutely prevents the passage of wagons or wheeled vehicles. From the 32d parallel to its mouth, the Pecos is always navigable for small stern-wheeled boats, the difficulties consisting merely in its extreme crookedness and narrowness. The banks are perpendicular, about ten feet high, and falling into the stream constantly—the deep water being uniform from one shore to the other. The average width would not exceed one hundred feet.

It is not deemed advisable to encounter that *terra incognita*, the Llano Estacado, with the whole command, until the practicability of such a measure shall have been tested by a previous examination. Our very limited information respecting it points out the necessity of such an examination, to avoid the danger to which so large a party would be exposed by encountering this Jornada. Captain Taplin was intrusted with this important duty. The following is a copy of his instructions:

FALLS OF THE PECOS RIVER, MOUTH OF DELAWARE CREEK,
March 9, 1854.

SIR: You will please proceed to examine the "Llano Estacado," from this point to the head-waters of the Colorado or Brazos river, on a line 20° east of north, noting particularly the practicability of the country for wagons, and the intervals, as exactly as possible, between the permanent watering places. You will continue your examination eastward until you strike some stream flowing to the east or south.

Should you be successful in finding water at reasonably convenient intervals along your route from this point, you will, after resting your animals one day, return by the same route; but if not, you will please, after reaching any stream flowing eastward, and at a distance of more than sixty miles from this place, to make twenty-five miles of southing, and from thence return in a direct line to this camp.

Your party will consist of five mounted men of the topographical party, and five infantry

soldiers of the escort. You had better keep the mounted men scouring the country for a mile or two on each side of the route you pursue, that no chance of finding water be lost.

The quartermaster and commissary of the expedition will supply you with two light wagons, with eight mules each, and provisions for ten days, for the use of your party. Six water-kegs will be filled here and carried with the party, and I cannot too strongly impress upon you the necessity of economizing this supply of water. Two kegs will be amply sufficient to supply all the absolute necessities of the party for five days, at least; and in case of being three days without water, or the failure of your mules for the want of it, the remaining four kegs can be distributed among them. The other precautions for preserving the strength and efficiency of your animals are as well known to you as to myself.

Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JNO. POPE,
Brevet Capt. T. E., Commanding Exploring Expedition.

Capt. C. L. TAPLIN,
Assistant on Survey.

This day we (for the first time since starting) became aware of the vicinity of the Indians. About sundown we perceived the prairie on fire about two miles from camp, up the river; the wind blowing from the northeast, and directly towards us. As the grass and weeds were dry, and the wind strong, the flames rushed onward with great rapidity. Instant and prompt measures were taken against this appalling danger. The prairie was fired round the camp, from the river to the creek. We were thus in a triangle, the *Pecos* and *Delaware* being the sides—the belt of prairie we had burned, the base. There can be no doubt whatever that this was an act of the Indians, as we could clearly see the plain fired in many and different directions at the same time. The fire swept on round the camp, and crossing the creek some hundred yards above us, and seizing the dry grass on the right bank, illuminated the whole plain during the night. Happily, our energetic proceedings defeated the designs of the Apaches. On the first intimation of danger, the animals and stock were driven into camp—the former tied to the wagons, the latter well guarded. It is intended to adopt this precaution every night while we remain here, and also to increase the guard over them while they are grazing in the daytime.

No observations made this night; the sky cloudy and hazy. They were taken for the time during the day.

Same Camp—Friday, March 10, 1854.—Lieutenant Garrard, accompanied by a party of five mounted men, left camp at half-past 7 o'clock a. m., in pursuance of the following instructions:

CAMP AT FALLS OF RIO PECOS, MOUTH OF DELAWARE CREEK,
March 9, 1854.

SIR: You will please proceed from this place, by the route we have just traversed, to the spring in the cañon near the high peak of the Guadalupe mountains; and having descended to the valley of the Salt lakes, you will examine the western and southern faces of the low range of hills which extend to the south and east from the high point of the Guadalupe range. It is generally believed that a practicable and nearly level pass can be found to the head of Delaware creek, by passing to the south of these hills; and should you be successful in finding such a pass, you will please return by it to this camp.

Should you prove unsuccessful in finding a pass better than the one at present in use, you will please examine the valley of the Salt lakes towards the southeast, to ascertain whether a good route cannot thus be found to the Pecos, which shall strike the river at a distance south of this point, not to exceed sixty miles.

You will please take, as accurately as possible, your compass courses and distances for the entire survey, both going and returning, and will note every peculiarity of country, (timber, grass, water, &c., &c.) When you arrive at a point from which you can see the peaks of the Alamos mountains, please take accurate bearings to them and to the high peak of the Guadalupe mountains. It is absolutely necessary that a compass course and estimated distance be observed for each marked change of direction; as without a continuous set of courses and distances it will be impossible to make a sketch of your route.

A party of five mounted men, with rations for six days, will be detailed to accompany you.

Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JNO. POPE,
Brevet Capt. T. E., Commanding Exploring Party.

Lieut. K. GARRARD, 1*st Dragoons*,
Assistant on Survey.

The prairie fires still continue to burn over the surrounding plain, but all fear of injury from them has disappeared. Neither have we had any further Indian demonstration. The command has abundance of fish to eat, and we have caught some weighing upwards of thirty pounds. We saw some turtle floating down the stream, but were unable to catch them.

The animals and stock were driven in at sunset; the former got some corn, and were tied to the wagons during the night, strongly guarded.

Observations for time taken this day, and at night for latitude and longitude.

Same Camp—Saturday, March 11, 1854.—Observations for time made in the forenoon; heavens clouded up at night.

Same Camp—Sunday, March 12, 1854.—Heavens clouded during the day and night.

Same Camp—Monday, March 13, 1854.—Heavens clouded during the day and night.

Same Camp—Tuesday, March 14, 1854.—Heavens clouded in the forenoon and afternoon. Observations for longitude and latitude taken at night. Lieutenant Garrard and party arrived in camp at 3 o'clock p. m.

Same Camp—Wednesday, March 15, 1854.—Lieutenant Marshall, with seven men, rationed for four days, proceeded up the Pecos with instructions to examine it as far as the Sacramento river, which is supposed to be within two days' travel of this point. The main object of this expedition is to ascertain the correctness of the report that there is an abundance of large timber of all descriptions on the banks of the Sacramento, and also (if such is the fact) to ascertain if it be possible to raft this timber down to the Pecos. Lieutenant Garrard, according to his instructions, presented a report of his expedition, of which the following is a copy:

CAMP ON FALLS OF RIO PECOS, MOUTH OF DELAWARE CREEK,
March 15, 1854.

CAPTAIN: In obedience to instructions conveyed to me in your letter of the 9th instant, on the morning of the 10th I left this camp at 8 o'clock a. m., and reached the spring in the cañon near the high peak of the Guadalupe mountains at $10\frac{1}{2}$ a. m. the following morning, a distance of about sixty miles. Leaving the spring at 11 a. m., I proceeded in a direction east of south along the base of the western slope of the Guadalupe mountains, and encamped about eighteen miles from the spring. During the whole distance the mountain range presented a rocky and almost perpendicular side, intersected now and then by cañons opening into the plain, which proved, on examination, to narrow as you ascended them; terminating in steep ravines, and practicable only for horse or mule trails, being used as such by the Indians.

On the morning of the 12th instant I left camp at 6 o'clock a. m., and, continuing on the same course I travelled yesterday, I crossed over a ridge near where this range of mountains

appears from the road to terminate; and descending again into the valley of the Salt Plain, I found that what has been considered the terminus of the Guadalupe mountains is merely a spur running out from the main range in a southwesterly direction into the Salt Plain—the main range itself continuing uninterruptedly in the same course as it has north of the spur for many miles. I proceeded on for about fifteen miles on a southeast course, and found the mountains became higher and more rugged as I advanced along their base, retaining this character for about thirty miles to the south, where they appeared to terminate against the northeastern slopes of a range of mountains which extends from the northwest across their course. Being now more than a day without water, and having travelled over a hundred miles from our camp at the mouth of Delaware creek, and the object of the expedition having been accomplished, I at this point turned back, and, following my trail for about ten miles, bore off northeast across the mountains, direct for Delaware springs. Ascending cañons, and leading our animals up the almost perpendicular sides of the mountains, I encamped towards evening near three beautiful natural tanks of water, which I discovered by following an Indian trail.

The next morning, (March 13,) starting a few moments before 6, and crossing the dividing ridge of the Delaware valley and the Salt Plain, I followed, in a northeast direction for about fifteen miles, a ravine which afterwards became a cañon; then, bearing more to the north, and crossing a succession of low hills, I struck the road near the head springs of Delaware creek, and encamped at the springs at 2½ o'clock p. m.

In conclusion, I have to report that there is not, within forty miles of the high peak of the Guadalupe mountains, a pass through them more practicable than the one which the road now traverses; that which appears from the road to be the terminus of these mountains, and has been generally considered as such, is a spur running out into the Salt Plain—the main range itself continuing without interruption for seventy or eighty miles east of south from the high peak, becoming more impracticable as you proceed to the southward; that the chain of Salt lakes which lie along the western base of the Guadalupe mountains, and which have been supposed to have their outlet into the Pecos around the southern and eastern bases of the range of bluffs extending south and east from the high peak of the Guadalupe range, have no such outlet.

I found grama-grass of good quality in great abundance along the entire route both going and returning, and water in the following places, viz: in natural tanks about thirty-five miles southwest from the head springs of Delaware creek, and about twenty miles east of south from the high peak of Guadalupe mountains; and again in water-holes for three miles along the course of a ravine in a direction north, and about five miles from the tanks. The water in all these places was rain-water, collected in natural cisterns; but from their appearance, and the quantity of water in them, it is likely it can be found there at all seasons of the year. These points are no doubt the habitual resorts of the Apache Indians, as there were numerous well-beaten trails leading to them from all directions, signs of frequent encampments in the neighborhood, and figures drawn by the Indians upon the rocks, sketches of which are to be found in my note-book. We saw also at the tanks fresh tracks of a party of Indians who had evidently passed only a few hours before us.

There was no large timber of any kind along the routes, but in many places along the ridges there is a considerable growth of scrub-pine and cedar.

I transmit herewith a sketch of the route pursued by the party.

I am, Captain, respectfully, your obedient servant,

KENNER GARRARD,

Lieutenant First Dragoons, Assistant on Survey.

Brevet Captain J. POPE,

Top. Engineers, Commanding Exploring Party.

Observations for the time made during the day. The heavens cloudy at night. The mules

and stock driven across the creek, and allowed to graze during the night; they, as usual, were hobbled, and placed under under a strong guard. This course was adopted for the purpose of economizing the corn. It is not anticipated that any injurious result will follow from this arrangement, (during our stay here,) as every precaution that prudence can dictate is taken to prevent surprise.

Observations for the time made during the day. The heavens cloudy during the night.

Same Camp—Thursday, March 16, 1854.—The following is a copy of Lieutenant Marshall's instructions:

FALLS OF THE PECOS RIVER, MOUTH OF DELAWARE CREEK,
March 14, 1854.

SIR: You will please proceed to examine the Pecos river as high up as the Sacramento, provided that point be not more than seventy miles distant from this place. It is reported in New Mexico, by those who profess to know, that the valley of the Sacramento river is abundantly supplied with large timber of every description, and you will investigate the truth of these statements. Should such prove to be the fact, you will please examine the Pecos carefully from the mouth of the Sacramento to this point, with a view to ascertain if the timber can be conveniently floated or rafted down that stream. You will also note every peculiarity of country along your routes as to timber, grass, water, &c., &c., and will keep a set of accurate compass courses and estimated distances for the entire expedition. A party of seven mounted men, with rations for four days, will be detailed to accompany you. Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JOHN POPE,
Bvt. Capt. Top. Engs., Commanding Exploring Party.

Lieut. L. H. MARSHALL, 3*d Infantry*,
Commanding Escort.

Lieutenant Marshall and party returned to camp at sundown. (For his report see Friday, 17th instant.) The weather for the last few days has been intensely warm—this day particularly so, the mercury rising to 97° Fah. in the shade. Many of the men have bathed in the creek; the temperature of the water pleasant and refreshing. The young grass is springing up on the ground that was fired a few nights ago. The prairie still continues to burn; the light can be seen at a distance of 45 miles from camp, near the Sacramento river. The mules and stock, (the former hobbled,) under a strong guard, grazed during the night. The animals which returned with Lieutenant Marshall were the only ones fed with corn.

Although the water of the Pecos is somewhat salty, and that of the Delaware creek considerably impregnated (from the springs above) with sulphur, yet the use of it has not been followed by any injurious consequences to the health, of a serious character. Some few of the party have been attacked, but not seriously, with diarrhœa, which disappeared in two or three days on applying simple remedies. It is observed that the animals prefer the sulphurous water.

Lieutenant Garrard made some surveys in the vicinity of camp, which will be duly noticed. We have added largely to our collection in natural history, &c. All repairs to wagons, harness, &c., are being made; indeed all hands are usefully employed. Observations for the time made during the day, and at night for latitude and longitude.

Same Camp—Friday, March 17, 1854.—Lieutenant Marshall presented the following report, in compliance with the concluding paragraph of instructions dated 14th instant:

CAMP NEAR FALLS OF PECOS,
March 17, 1854.

CAPTAIN: In obedience to instructions received from you on the 14th instant, I have the honor to report the result of the expedition under my charge.

I left camp on the morning of the 15th instant at 9 o'clock, and travelled in a northeast direction, for the greater part of the time along the right or west bank of the river, until 6 o'clock p. m., when I camped, having marched thirty-seven miles. About three miles from camp I met a party of Apache Indians, under their head chief, Negrite, who had a paper from the commanding officer of Fort Fillmore, giving him a good character. * * * They approached me with a white flag and said they were good Apaches, who wished to be at peace with the whites; they informed me that the Sacramento was near.

The country over which I passed was a rolling prairie, similar in all respects to that traversed between the head of Delaware creek and the Pecos. The soil, a mixture of clay and decomposed gypsum, evidently rests on a bed of limestone and a conglomerate of limestone and clay, which outcrops at several points along the river. On the left or east bank of the river is the broad plain of Llano Estacado, which evidently has for its basis the same conglomerate rock mentioned above.

On the morning of the 16th I left camp at 6 o'clock, and travelled for about a mile along the bank of the Pecos—passing through a grove of young ash-trees, the first and only timber I have seen on the river. I then ascended to the plain, and at the distance of half a mile came suddenly upon a stream, which I concluded to be the Sacramento. This river is about fifty feet wide, and six feet deep at the mouth—a slight bar forming on the right bank: the bottom is gravelly and hard; in some few places there are quicksands. The river varies from two to fifty feet in width, and in depth from one to fifteen feet. Its course is in some places zigzag, and there are three or four hackberry trees on the right bank, near its mouth. The water is clear and good, having a slight metallic taste. There is plenty of cat-fish and suckers of a large size near the mouth of the river. Trout can be caught higher up the stream.

I went up this river five and a half miles due west; it then turned to the northeast. At the bend of the river I found an Indian town, consisting of five or six wigwams.

I now determined to retrace my steps—not having found timber, nor seeing any probability of finding it within a few miles. I went back along the bank of the river to a point half a mile east of the bend, and crossing the river there, I rode over an ascending plain directly north of the ford until I reached a round mound, about three miles from the ford, from the top of which I could see the Guadalupe range sink into the valley of the Pecos. I could also perceive the Sacramento enter the chain of high hills which rise out of the plain about ten miles on the south side of, and continue until it connected with, the Guadalupe range; also the depression in the Guadalupe chain, through which I supposed the Sacramento must pass. The country on the right bank of the river is of precisely the same nature as that described above. On the left the soil is a red clay, resting upon a stratum of gypsum. I passed some caverns on my way to and from the hill. There are several falls in the Sacramento—one of them a fall of six feet.

In the Pecos there are six or eight rapids; I refer you, for their locality, to the accompanying sketch of the route. I made a collection of such minerals and flowers as I thought would exhibit the character of the country. I reached camp at sundown.

In conclusion, as far as I could see from the hill before mentioned, the timber (if there be any on the Sacramento) must be north of the Guadalupe chain; and, in my opinion, it would be impossible to float even a small log down the Sacramento, although a very large one could be very easily rafted down the Pecos.

I have the honor to be, respectfully, your obedient servant,

L. H. MARSHALL,
Second Lieutenant Third Infantry.

Brevet Captain JOHN POPE,
Commanding Exploring Party.

Lieutenant Marshall further reported having seen a considerable quantity of deer, antelope, and partridges along the route.

A stone monument was erected on the summit of a hill on the right bank of the Delaware creek, for reference on the survey across the Llano Estacado.

The mules and stock grazed during the day and night, under a strong guard, on the south side of the creek.

No observations taken this day; the heavens cloudy at night.

Same Camp—Saturday, March 18, 1854.—Some surveys made to find the levels of the river: the result is a fall of three feet one inch in three hundred feet. The mules and stock grazed as usual; were brought in at sunset, fed with corn, and then turned out to graze during the night.

The principal wagonmaster, (Mitchell,) accompanied by a Mexican, came into camp, with a letter from Captain Taplin. As this letter gives a mere outline of his expedition, it is not copied in this place. (The full report of this expedition is given at page 73 of this journal.) The following is a general statement of the route of the party over the Llano Estacado, as given by the wagonmaster. He says: "For about eighteen miles after leaving our camp the road is good. At this point it becomes heavy sand, which continues the whole way across the Staked Plain until about the same distance from water on the opposite side. The intermediate plain is entirely destitute of water. The party accomplished the distance, (say one hundred and forty-two miles) from water to water in five days. In consequence of the exhausted condition of the animals, the wagons were abandoned on the fourth day, about forty miles from water. After reaching the springs (which Captain Taplin supposed to be one of the sources of the Colorado) the mules were rested a day and a half, but were too much broken down to justify Captain Taplin in attempting to rejoin the command. He therefore sent wagonmaster Mitchell to report the fact, and his intention of attempting to rejoin us by the emigrant trail. Mitchell brought a Mexican and three mules, one packed. Two kegs of water were carried along, half a keg of which was left at the wagons for the use of those persons who would come for them. He (Mitchell) left Captain Taplin on the 16th instant at 3 o'clock a. m., travelled until 4½ o'clock p. m.; camped; and started on the 17th at 4 o'clock a. m., travelled until 4 p. m., resting during that time for half an hour, then proceeded until 8 o'clock p. m.; camped; and started on the 18th at 3 o'clock a. m., travelled until 10 o'clock a. m., resting an hour, then proceeded to camp on Pecos, reaching it at sundown: thus making the whole distance (one hundred and forty-two miles) in forty hours' travelling. There are game, grass, and wood in abundance on these plains, but not the slightest trace of water."

The total impracticability of crossing the Llano with our wagons being now obvious, and the command so much divided, it was decided to move down the east side of the Pecos to intersect the emigrant trail and meet Captain Taplin. Immediate preparations were made for this movement.

Camp 19—*Sunday, March* 19, 1854.—Left camp at daylight and crossed the river. As the banks had been cut down to facilitate the crossing of the wagons, they passed over without any accident, with the exception of one, which had its hounds broken, the repairing of which occasioned some delay. The bottom of the river at this point is rocky, and no difficulty whatever is presented if proper care is taken.

About half of our route to-day was over a rolling prairie, which was easy to travel; the remainder was level. The road was good, being composed of sand and gravel. For the second time during the expedition we had a slight fall of rain, which commenced before we left camp and continued until noon, when it cleared up, the weather becoming excessively hot.

At four miles from camp we came upon a deep-red soil, (sandy,) which continued until we struck the level plains.

The greater portion of the soil passed over to-day is capable of extensive culture; it can be irrigated from the river. Along our route there was a considerable quantity of mezquite-root and brush mezquite; also the grama-grass was good and abundant.

Reached our camp on the "Rio Pecos" at 3 o'clock p. m. The banks of the river are here steep and precipitous, rendering it impossible to water animals at it without cutting them down.

This was done with a little labor. We had an abundance of mezquite-root; the grass was good and plentiful. Immediately on our arrival in camp the animals were watered and turned out to graze, the mules being hobbled, as usual. At sundown they were brought in, fed with corn, and turned out for the night, strongly guarded.

No observations taken; heavens cloudy during the day and night; general direction, south 40° east; miles, $12\frac{4}{10}$.

Camp No. 20—*Monday, March* 20, 1854.—Left last camp at 7 o'clock a. m. With the exception of a short distance of rolling prairie, our route to-day was over a level and rich bottom, which widens as we descend the river. This valley can be easily irrigated, and would, no doubt, amply repay the outlay and labor. The grass in the bottom is not so good as it has been; it is only tolerable prairie-grass; but on the bluffs the buffalo-grass and grama-grass are excellent. The under-ground and bush mezquite is abundant. On one of the bluffs, composed of a deep-red sandstone, we found the sulphuret of lead, rich in silver.

We camped at 4 o'clock p. m. near a sloping bank of the river, where the animals could be watered without the use of buckets. It is to be observed that the banks of the river are so steep that the animals must, speaking generally, be watered by hand. At this camp we for the first time met with an accident. One of the mules, getting into deep water and quicksand, was drowned. The current was so swift and strong that it was impossible to save the animal. The mules and stock, having been watered, were fed with corn, afterwards hobbled and turned out to graze during the night, strongly guarded. Mezquite and brush plenty; grass (prairie) only tolerable.

During the day we saw several Indian trails, which had been travelled very recently.

No observations taken; heavens cloudy during the day and night. General direction, south 35° east; miles, $19\frac{6}{10}$.

Camp No. 21—*Tuesday, March* 21, 1854.—Left camp at half-past 6 o'clock a. m. Our route during this day's march was over a slightly rolling prairie. We saw an abundance of under-ground mezquite. The grass has changed from grama to prairie grass of an inferior quality. As on the previous day, we found excellent buffalo-grass on the bluffs. The flowers, before so profuse, have entirely disappeared in the valley; they, however, grew abundantly on the bluffs and high gravelly ground. The soil to-day was good, and can be cultivated by irrigation from the river. The bluffs gradually recede as we proceed down the river. The last one we saw before reaching camp is about three miles from it. We saw several Indian trails, which became more defined as we approached camp, which we reached at twenty minutes after 2 o'clock p. m. This camp is evidently a favorite resort of the Indians, as the deep trails leading to it sufficiently prove. Animals can be watered here with great facility, as the bank slopes gently down to the water. The mezquite root is not very plenty in the *immediate* vicinity of camp. We, however, found enough of it and brush to answer all purposes. The prairie-grass is tolerable.

On one of the bluffs (above mentioned) a gold-bearing quartz was found.

From evidences brought under our notice to-day and yesterday, there can be no doubt that this section of country is rich in the precious metal. It remains for our more fortunate successors to reap the benefit of this opinion.

We are now, it is believed, about twelve miles above "Marcy's Crossing."

The animals and stock were watered and turned out to graze—the former hobbled.

As we are now in a dangerous country, the following precaution is taken against surprise: Six of the best animals are kept in the corral, so that, in the event of a *stampede*, they can be made available to recover the other animals. For the future, except under peculiar circumstances, the riding-mules will not be fed with corn.

No observations taken during the day or at night. General direction, south 80° east; miles, $17\frac{2}{10}$.

Camp No. 22—*Wednesday, March* 22, 1854.—Left last camp at half-past 6 o'clock a. m. Our route for about six miles was over a tolerably good prairie, the soil being good—sand,

mixed with gravel. It then changed to a yellow, soft sand, covered thickly with chaparral. The ground is much cut up by mole and prairie-dog holes, which render the travelling fatiguing to the animals, as they are constantly sinking into them.

We could distinguish an immense salt lake in our front for many miles before we arrived at it, in which there appeared to be a large body of water. However, on crossing it, we found it perfectly dry. It is upwards of two and three-quarter miles across, and is covered over with a salty efflorescence. As the sun shone fiercely upon its dazzling surface, the effect upon our eyes was most painful. On digging, the soil became moist. At the depth of two and a half feet we came to water, the taste of which was intolerable.

We had here an interesting instance of the power of refraction. As the mounted party arrived at the lake before the wagons, the men behind supposed we were standing in water. When they reached the lake, they also appeared to be wading through water. We saw some antelope here, but did not succeed in killing any; they were shy.

On leaving the lake, we proceeded to the river over a soft and heavy red sand. It was very bad travelling for the wagons. The grass became scanty and bad. We reached camp at ten minutes after 4 o'clock p. m. The most convenient place was selected for watering the animals, yet we had to use buckets—it being dangerous to allow them to drink from the bank, which was steep and miry. Mezquite-root scarce in the neighborhood of camp. We found some drift-wood on the banks of the river. The grass being of an inferior quality, the mules were fed with corn, hobbled, and grazed during the night, under a strong guard.

Until the last two or three miles, the mezquite and grass were abundant. Altogether, the country to-day was far inferior to that we have traversed for some time past.

No observations taken during the day; the night cloudy, with a slight rain. General direction, south 50° east; miles, $20\frac{4}{10}$.

Camp No. 23—*Thursday, March* 23, 1854.—Left last camp at twenty minutes to 7 o'clock. At a short distance from it we found a long stake driven firmly into the ground on the bank of the river, evidently intended as a mark or guide, but by what party put there we could not ascertain. We now struck a wagon-trail, which we supposed to be Marcy's. However, on following it up for some miles, it terminated abruptly. After considerable search for it, without success, the command halted and turned back, and, at a mile and a half distant, encamped near the river. Two parties were sent out to hunt up the trails; one of them struck it about three miles from where we halted.

Our road to-day was good; the soil gravelly, and mixed with sand. The bluffs approach nearly to the river's edge. Indeed, at one point the road was barely broad enough to permit a wagon to pass along the stream. This portion of our route was thickly covered with gypsum and shells; the former in larger masses than we had yet seen. Selenite was also abundant. On cutting off a piece of it with a penknife, it was found to be as clear and transparent as glass. Indeed, the poorer classes of the Mexicans, and all the pueblos in New Mexico, use selenite of a much inferior quality as a substitute for this necessary article.

The soil to-day consisted of a firm red sand, mingled with clay; the bluffs are red sand. The grass assumed a completely different hue, becoming quite green; the effect was pleasing to the eye. There was prairie-grass in the bottom, grama and buffalo-grass on the bluffs—all excellent and abundant. We reached camp at 11 o'clock a. m., on the bank of the river. The animals and stock were driven about a mile from camp to an old camping-place, where they could be watered without using buckets. On their return the mules were hobbled and turned out to graze; the wagon mules, and those retained in camp for the purpose already mentioned, only fed with corn. Animals grazed at night, guarded as usual. Mezquite root and brush plenty along our whole route to-day.

For the last few days the rattlesnakes are becoming numerous. The weather is oppressively sultry, the thermometer ranging from 84° to 88° in the shade.

Our botanical collection is increasing, every day disclosing some new and beautiful varieties of flowers.

It is deeply to be regretted that our limited means of transportation does not permit us to increase our geological and mineralogical collection to the extent we desire, as the country affords us abundant opportunity of extending our researches in these branches of science. We continue to be fortunate in our collection of natural history. Observations for the time taken in the afternoon. Heavens cloudy at night, with a slight rain. General direction, north 82° east; miles, $7\frac{2}{10}$.

Camp No. 24—*Friday, March* 24, 1854.—Left last camp at twenty minutes past 6 o'clock a. m., and moved in the direction of the trail discovered yesterday. We struck the road at the "Emigrant Crossing" about 9 o'clock a. m.; distance from camp upwards of four miles. This is an extremely bad crossing; our oxen swam for upwards of thirty feet to the opposite bank. It would be utterly impossible for wagons to cross without rafting. It cannot for a moment compare with the "Crossing of the Pecos," (mouth of Delaware creek,) the former presenting many difficulties—soft bottom, deep stream, and on the east side miry banks. The latter affords many facilities, and is strongly recommended to emigrants. We halted here to water, which had to be done with buckets. As we will not reach water until we strike the "Sand Hills," our kegs were filled. We are now upon the long-desired trail.

Our route was over a rolling prairie; the soil is gravel, mixed with clay. Grama-grass good and abundant. On both sides of the road there was plenty of mezquite-root and brush.

We reached camp at half-past 3 o'clock p. m. No water. Mules and stock turned out to graze. The arrangement of the previous night continued.

Observations for the time taken during the afternoon; also for the latitude at night. The latter had to be discontinued, as the heavens suddenly clouded up, with every indication of a coming storm.

During the day we espied a mule grazing at some distance to the right of the road. We approached him, but he evinced an evident dislike to our further acquaintance, taking to his heels in gallant style, affording quite a hunt to the mounted party, which he certainly "distanced." However, we accomplished by stratagem what we failed to do by speed. After some difficulty he was driven into the herd, and "lariated" by the Mexicans. He was at once put in harness, and worked well, taking this sudden change in his condition most philosophically. On examination we found him branded with the "U. S." mark. Being in good order, the animal was a valuable accession to our teams. General direction, north 16° east from the river; miles, $19\frac{8}{10}$.

Camp No. 25—*Saturday, March* 25, 1854.—Left last camp at twenty minutes after 6 o'clock a. m., and moved in the direction of the Sand Hills. Our route to-day, for nine miles, was over a level prairie; the road for this distance was excellent. Before reaching the "Hills" we had nearly seven miles of bad, sandy road. We could perceive them at a distance of twelve miles, stretching away as far as the eye could reach. For two miles, before camping, we passed around their western base. We arrived in camp at twenty minutes after 2 o'clock p. m.

These "Hills" present a curious and interesting geological formation. They extend about fifty miles from north to south, and fifteen miles east to west. They consist of white drift-sand, thrown up into innumerable conical mounds, totally destitute of all vegetation. One would suppose that this region of sand is the last place where water could be found; yet, however incredible it appears, there is an abundance of water in these hills, contained in basins of the finest sand. When amongst the "Hills," one would suppose there had been a heavy fall of snow. Our camp was about a quarter of a mile from the water. The animals were driven up to water, sinking to their knees in the sand. The team-mules were fed with corn; six animals picketed in camp for the purpose previously mentioned.

The soil for ten miles from the Pecos was good, with plenty of prairie grass and mezquite

root. As we near the "Hills," these become scarce. At camp we had some brush. The grass was very poor and scanty.

The weather changed suddenly to cold, with a high wind. A slight rain fell during the night.

Our camp is thirty-one and two-tenths miles from the "Emigrant Crossing" of the Rio Pecos. No observations taken during the day. Heavens cloudy at night. General direction, north 7° 30′ east; miles, $16\frac{4}{10}$.

Camp No. 26—*Sunday, March* 26, 1854.—Left camp twenty minutes to 7 o'clock a. m., and proceeded in the direction of the next watering-place in the Sand Hills, five miles distant from camp. There is a well marked trail here leading to the water, which can be obtained, however, at any point in the "Hills," by driving the animals about half a mile from the road. The mules and stock were watered and turned loose to graze some time. We passed from last camp from northeast to southwest in arriving at this point, over a deep sandy road, which was very trying to the animals. From the great quantity of fragments of abandoned wagons, this place has been evidently a general camping ground.

Having halted about an hour and a half, the command started. The remainder of our route for this day was over a fine and deep sand; we encountered many steep hills of the same nature. There could not, indeed, be a worse road, as was sufficiently evident from the exhausted condition of our animals. We fortunately overcame all the difficulties of this miserable road without doubling teams or meeting with any accident. As we did not expect to reach water until the following day, all the casks were filled at the above halting place. The grass is poor and scarce; there is no wood, although we found enough of brush and weeds for cooking. In short, there is no vegetation on this arid and sandy plain.

We reached camp after a laborious and fatiguing march at $3\frac{1}{2}$ o'clock p. m., and camped without water. The same arrangement as last night respecting the mules.

The weather continues cold; had it been as hot to-day as it has been for some time past, it is doubtful if we could have succeeded so well.

A party under assistant wagonmaster Beylor was sent out at daylight to go ahead and find water. By some inconceivable mistake they took the trail (at which we watered) instead of the road; and having wandered about for a number of hours, completely bewildered, they accidentally came upon our track.

No observations taken during the day or at night. General direction for five miles to watering place, northeast to southwest; remainder of the day, north 20° east; miles, $12\frac{6}{10}$.

Camp No. 27—*Monday, March* 27, 1854.—Left last camp at twenty-five minutes after 6 o'clock a. m. For about five miles we encountered the same deep sand we had yesterday. The remaining portion of our route to-day was over a good gravelly road. Lieutenant Marshall and four of the party left the command early in the morning to find water. He met us near our camping place in the evening, having gone thirty miles without discovering any. The grass along our route is tolerably good; the mezquite root is not so abundant as it was before we struck the Sand Hills. We reached camp ten minutes after 5 o'clock p. m. No water; grass (prairie) tolerable; the mezquite-root requires some trouble to collect. We had sufficient water in kegs for cooking purposes, but it was used with economy, as we do not know if we will strike water to-morrow. We saw a large number of antelope to-day; but they were so shy, we did not succeed in killing any of them.

The soil, after leaving the sand, was composed of a fine sand mixed with clay; decomposed gypsum was lying pretty thick in some places.

The day was not so hot as usual—a fortunate matter for the animals, which, as yet, do not exhibit any particular sign of wanting water; they were halted at 10 o'clock a. m. and allowed to graze for a short time.

The arrangement of the preceding night in respect to the mules is continued.

Observations for the time taken in the forenoon; afternoon and night cloudy. General direction, north 50° east; miles, $18\frac{9}{10}$.

Camp No. 28—*Tuesday, March* 28, 1854.—Left last camp at 7 o'clock a. m. From various accounts we anticipated meeting with water to-day in more than one pool on our route. In these hopes we were sadly disappointed. Parties were sent out in every direction to look for it, and our anxiety was increased as each of them returned with an unsuccessful report. The animals were now showing symptoms of wanting it. The heavy dews of the last two nights have, in some slight measure, relieved their thirst, and this, together with the fact that the days have been cool, has enabled us to travel the frightful road we have traversed since Sunday last.

Every gully and pond where water was likely to be found were visited, but in vain. Our only alternative to prevent the loss of our animals was to push on briskly for the "Mustang springs." We halted once during the day to rest our animals, and then proceeded at a steady pace. The grass was good until within six miles of our camping place, when it changed, becoming poor and full of weeds.

We saw a number of antelope and deer to-day; one of the party shot two deer. On a ridge near camp we perceived a mustang, the only one we had yet met with.

The soil is much the same as yesterday; our road is an excellent one.

Reached camp at $5\frac{1}{2}$ o'clock a. m. No water, the animals evincing signs of fatigue, having been two days and nights without water; grass very poor; mezquite and brush plenty.

There was not sufficient water left in the kegs for cooking, through the injudicious conduct of some of the command in drinking it during the day. The matter was investigated, and some of the party punished to prevent a repetition of so serious an offence. Our good spirits do not, however, fail us, as we hope to strike water to-morrow about 10 a. m. Same arrangement as usual with regard to the animals.

No observations taken; day cloudy; it blew hard at night. General direction, north 52° east; miles, $25\frac{8}{10}$.

Camp No. 29—*Wednesday, March* 29, 1854.—Left last camp at 6 o'clock a. m., and moved for the Mustang springs, over a rolling prairie. About three miles from camp we met Captain Taplin and party, all well and in good spirits. His report, and a detailed account of his proceedings, will be given in the subsequent pages. We arrived at the Mustang springs at half-past 10 o'clock a. m. Last night all our sheep (thirty-two in number) were stampeded by the wolves, and our exertions for their recovery were in vain. This is deemed an appropriate place to take a retrospective glance at our road for the last few days.

From the point where we first struck the Sand Hills, we proceeded along their western base and crossed the main ridge of sand at the lowest apparent point. At five miles across, we came to the last known watering-place to the eastward. In this direction we passed over many ridges of deep sand, separated by valleys of the same character. They are in reality impassable for heavy-laden wagons. From the above point to the hard prairie east of the Sand Hills, a distance of thirteen miles, we continued to cross deep sandy ridges, with intervening bottoms of a similar description, totally destitute of vegetation. From the Pecos river to the level prairie east of the Sand Hills, the road passes through about thirty miles of the heaviest sand. It is the worst road to be found in New Mexico, on the Rio Grande, or indeed anywhere else. It cannot be too strongly urged upon emigrant parties never to attempt travelling by this route, except in the rainy season, from August to the middle of October, as the distance without water from the Sand Hills to the first permanent water to the eastward is sixty-seven miles, thirteen of which (immediately to the eastward of the hills) are through sand so deep and heavy as to be absolutely impassable for heavy-laden teams. With animals perfectly fresh, and lightly-loaded wagons, it requires all our exertions to overcome the difficulties of this dreadful road. It is also to be observed that our animals were in fine order, with eight and ten mules to each wagon.

The Mustang springs form several lakes or large pools, which are highly saline. The one

on which we camped, the most easterly, is less salty than the others, and is by far the best for use. It is slightly sulphurous, but not very unpalatable. There are some holes dug around, in which the water is somewhat better than in the bottom. These lakes are about three miles in length, and run north 20° west, and south 20° east. They are enclosed by gentle eminences, on which the grass is better than in the bottom.

We met a party of Kiowas, who had a large number of horses and ponies, and were returning with them to their own country from Mexico. It is needless to say these animals had been stolen. The chief met us near our halting-place, and showed a friendly spirit. The Indians encamped at a short distance from us. With the exception of a few words with the chief, no further intercourse was held with them. They did come into our camp, but departed hastily towards the north.

The soil during this day's march is generally good clay, mingled with sand, with occasional gravelly places. The hills at the "Springs" are formed of decomposed limestone. There was no growth of wood, or even brush, along our route. The mezquite root is plenty, but difficult to get at. The grass is improving.

The animals were watered and driven up on the hills to graze. They were all fed with corn, and herded under a strong guard during the night, except six mules, which were picketed in camp, to be used in case of emergency.

Observations for the time taken during the day, and for the latitude at night. General direction, north 52° east; miles, 13.

Camp No. 30—*Thursday, March* 30, 1854.—Left last camp at 10½ o'clock a. m. Our route was over a rolling prairie; the road excellent. The animals, being now recruited, looked and travelled well. As we do not expect to reach water this evening, our kegs were filled, and the animals all watered before we started. On our whole route to-day we did not see any wood; the mezquite-root is plenty, but more difficult to obtain than usual. As we proceed, the grass improves. To the right of the road the plain was covered with young green grass, which the animals ate with great avidity. This green grass is the result of firing the prairie, which is done by the Indians on the grounds they most frequent. Occasionally the grass is fired accidentally; a fresh and excellent crop replacing the dry grass.

We reached camp at fifteen minutes past 2 o'clock p. m. We found good grass and mezquite-trees in considerable quantities.

The same arrangement in respect to the animals as on the previous evening.

No observations taken in the day; the wind blew a perfect gale at night from the north.

The soil during this day's march was a good clay and sand; we met with several places covered with decomposed limestone. This land could, no doubt, be cultivated successfully if there was either natural or artificial irrigation. Stock to an incredible extent could be raised on these plains near the watering-places. This result will perhaps be accomplished at a future day.

Camp No. 31—*Friday, March* 31, 1854.—Left last camp at five minutes to 7 o'clock a. m., and moved in the direction of the Big Springs, over a rolling prairie. About four miles from camp we descended into a fine valley, having a rich soil, covered with a fresh growth of grass. As we proceed the country assumes a different and more fertile appearance. On our route to-day there is a great quantity of mezquite, which becomes particularly abundant as we approach the "Springs." We reached our camp, Big Springs of Colorado, at twenty minutes after 12 o'clock p. m.

These springs are surrounded by immense masses of limestone rock, and are situated in a basin or reservoir of the same geological character, about sixty feet wide, and to all appearances about thirty feet deep. The water is excellent. On exploring the rocky eminences in the vicinity, we found large quantities of shell of the muscle species imbedded in the rock.

We have everything here requisite for camping—water, wood, and grass in abundance. It is one of the best camps we have yet stopped at.

The animals were turned out to graze; they were not fed with corn, except the few retained in camp. Corn was not necessary, as the grass is good, and the mules in capital order.

Observations for the time taken in the day, and also at night for the latitude. General direction, north 52° east; miles, $10\frac{8}{10}$.

Camp No. 32.—*Saturday, April* 1, 1854.—Left last camp at $9\frac{1}{2}$ o'clock a. m. Before starting, all our kegs were filled, and the animals watered, as we do not expect to reach water this evening. Immediately on leaving camp we crossed the beaten road which we had traversed from the Rio Pecos, and moved in a southwest direction. We at first encountered a succession of ravines and gullies, composed of lime and sandstone; but from these we did not experience any difficulty. By following a ravine we came upon a fine hard bottom, over which the wagons travelled well. It is to be borne in mind that we are now making our own road. Along our route we perceived many salt lakes without water; they were, with one exception, on the left. To the right of the bottom there is a table-land, which extended the whole way for this day's march. The wagons did not ascend, as the valley is the best road for travelling.

The soil is clay and sand, with gravel at intervals. In the immediate vicinity of the Lagunas the surface is covered with a saline efflorescence; the grass also is tinged with salt.

We reached camp at ten minutes to 2 o'clock p. m., where we had plenty of wood and grass; no water.

The same arrangements as last night in respect to the mules.

No observations taken in the day or at night. General direction, south 70° west; miles, $10\frac{6}{10}$.

Camp No. 33.—*Sunday, April* 2, 1854.—Left last camp at five minutes to 7 o'clock a. m., and moved in the direction of the Sulphur Springs of the Colorado, the first water reached by Captain Taplin's party; our road being over a hard and slightly rolling prairie.

The soil is a fine sand, gravelly in some places. The mezquite continues abundant. The grass is generally good, with some exceptions, when it becomes dry and weedy.

We have seen a considerable quantity of antelope, deer, and pheasants for the last few days; the former are so shy, it is difficult to get near them.

Reached camp—Sulphur Springs of the Colorado—at 3 o'clock p. m. In the neighborhood of the springs the mezquite root is scarce; but wagons can be sent about two miles from them where there is an abundance.

The usual arrangement respecting the mules continued.

No observations taken during the day or at night; general direction, north 70° west; miles, about 16.

CHAPTER III.—*From the Sulphur Springs of the Colorado to the Clear Fork of the Brazos.*

The following, which is the first portion of Captain Taplin's report of his exploration of the Llano Estacado, was received at the Pecos March 18, 1854:

SULPHUR SPRINGS OF THE COLORADO,
March 15, 1854.

SIR: In obedience to your instructions, dated March 9, 1854, to examine the Llano Estacado from the falls of the Pecos river, mouth of Delaware creek, to the headwaters of the Colorado or Brazos river, I have the honor to submit the following report.

On Thursday, March 9th, I crossed the Pecos at 11 o'clock a. m., in a direction north 70° east. My command consisted of wagonmaster Mitchell, six of the topographical party, and five men of the infantry escort—in all, thirteen persons—having two light wagons, with eight mules each, rations for ten days, six kegs of water, and eight sacks of corn; the number of mules was twenty-two, six of the party being mounted. This day we made eighteen miles, and encamped at $7\frac{1}{2}$ o'clock p. m.

About four miles from the Pecos we crossed a ravine with a grove of wild china trees upon it; some of these were twenty feet high. Our road was hard and gravelly, with the exception of the last three miles, which were sandy. This sand is red, and covered over with prairie-mole holes, into which the mules sunk above the fetlock every few steps. Along our route saw antelope, deer, and rabbits; there is an abundance of grass, dwarf mezquite, palmetto, and cactus. No signs of water.

Friday, March 11.—Left camp at 6 a. m.; our road continued sandy; mezquite-brush thick in some places. At half-past 12 p. m. we stopped twenty minutes to rest the mules. We then proceeded until 7 o'clock p. m., and encamped. An antelope and a rabbit were killed. The mules evinced signs of fatigue. No signs of water; distance this day, twenty-four miles.

Saturday, March 11.—Left camp at half-past 5 a. m. Having travelled about three miles, we struck a ravine leading to the south, in the bed of which were large boulders of sandstone; bluffs on each side. Two of the party were sent up and down this ravine to look for water, but without success; the wagons in the mean time continuing their course. From this point the face of the country changed to a hard and gravelly soil, with a rolling prairie, covered with grama-grass. Antelope, deer, rabbits, owls, crows, prairie-hens, and small birds were quite numerous. At half-past 1 p. m. the animals received one gallon of water each, and rested for an hour and a half. We moved forward at half-past 3 p. m., and again struck the sand, which is red and covered over with a coarse bunch-grass about two feet in height, and patches of dwarf-oak about six inches high, loaded with acorns.

About 9 o'clock a. m. perceived a high bluff, bearing southeast, evidently fifteen or twenty miles distant, facing to the west, and sloping gradually to the east; it serves as a landmark for miles around. From the abundance of game, there is no doubt water in that direction. We had plenty of dwarf mezquite, wild china, and brush along our route to-day. The mounted men are kept on the flanks, riding at a considerable distance, looking for water. Encamped at half-past 7 p. m. on the plain. No sign of water. The weather is cool, with frost at night—a cold wind blowing from the north nearly all the time. A fallow deer was killed to-day. Distance, twenty-five miles.

Sunday, March 12.—Left camp at half-past 5 a. m., and resumed our course through the sand-hills. The mules are much fatigued by the innumerable mole-holes. Stopped at half-past 12 p. m., and gave the mules the remainder of the water, except three gallons reserved for the men. The country, as far as can be seen, is a perfect sea of tall, reddish grass, interspersed with hillocks of sand. The mules are very much jaded; the water we brought from the Pecos being somewhat saline, does not seem to benefit them. Encamped at half-past 6 p. m. We have made but twenty miles in twelve hours; no sign of water.

As the country ahead of us does not appear to improve, it was determined, for the safety of men and animals, to leave the wagons and push on, being uncertain how far it may be to water. An antelope killed to-day.

Monday, March 13.—The men were called at 3 a. m. to arrange their packs; the escort were mounted, blankets serving for saddles. They had one pack-mule to carry their rations. We took two along, leaving the corn in the wagons. Started at 4 a. m.; the road continued sandy for about six miles. At this point we struck a hard, firm prairie, and again found grama-grass. Proceeded until half-past 11 a. m., and rested the mules for twenty minutes. The country is more rolling, with basins which evidently contain water in the rainy season. At half-past 2 p. m. we came to a small pond of muddy water, where our mules had a little water each, but the men could not drink it. Saw fresh mustang signs and two mustangs. Encamped at 6 o'clock p. m., without any sign of water. As usual, some of the party kept on our flanks, on the look-out for water; plenty of mezquite-root for fuel.

Tuesday, March 14.—Camp stirring at half-past 3 a. m. We started at 4 a. m. Although our mules were counted at midnight, and found correct, yet, through the carelessness of the escort, (who were on guard,) two of the mules got loose and strayed off. Every precaution was

taken against such a contingency; there was rope sufficient, and these men had been cautioned to be particular in picketing their animals. Our mules were suffering so much for water, we could not delay to hunt up these animals.

The country is becoming rolling. After travelling for six miles we came upon a high ridge, and saw to the north of our road a large ravine leading to the east; along its banks were stony bluffs. Still farther to the northeast was another high ridge, having about the same course; to the southeast high hills, apparently twenty-five or thirty miles distant. The whole face of the country slopes to the eastward. We struck a fresh trail leading down to springs in the ravine, which we reached at 9 a. m. Some of these are highly tinged with sulphur and saltpetre—others perfectly fresh and pure. They issue out from under a bed of limestone rocks. These springs are no doubt one of the sources of the Colorado. About a hundred yards below the head spring there is a large pond, at which animals can be watered with great facility. There had been recently a large party of Indians at this place; it is their regular camp-ground. The scarcity of grass and fuel in the vicinity is thus accounted for. They can, however, be found in abundance at the distance of a couple of miles. We will remain here until night, when we will move out for grass. At 4 p. m. moved out one and a half mile to good grama-grass, keeping a good look-out for our mules.

Wednesday, March 15, 1854.—Last night was cloudy and warm; towards daylight a heavy dew fell. At 11 a. m. moved back to the springs, unpacked and watered our mules; we will remain here till evening. The animals are so much broken down, it would be impossible for them to return to the Pecos without resting for two or three weeks. Mitchell and a Mexican will be sent back on express to the Pecos; they will start early to-morrow morning, taking a pack, with as much water as they can carry. Mitchell thinks he will reach the river on the third day, which will be about the twelfth since we started. In a couple of days the whole party will return for the wagons, and bring them to this place. The corn (about five sacks) will be issued as rations to the party; as the grass is good, the animals will not feel the want of it. If the party remain together we shall be on Captain Marcy's trail, which is not more than twenty miles from this point. It will require all our exertions to get the almost empty wagons here, (from the weak condition of the mules;) the distance going and returning is eighty-eight miles. On our return the animals will remain here for rest. When we move, it will be for grass or game, and then slowly. With the corn and the game we shall get, we will not, it is to be hoped, be driven to extremities; if so, we shall kill a mule. Our animals will be recruited as much as possible. In the event of not hearing from you soon, you will meet us on Marcy's trail. All have behaved well, with the exception of losing the two mules; the particulars of which are given above.

In concluding this portion of my report, I beg to state that I make the distance from the Pecos to these "Springs" one hundred and thirty miles. This I consider a low estimate. Throughout this whole distance there are no permanent watering-places. It is very doubtful whether water can be depended upon at any time, except immediately after heavy rains. This Llano presents many advantages for a railway; it would (an important consideration) require very little grading. I regret exceedingly that I cannot comply with your orders to return to the Pecos, the exhausted state of my mules rendering it utterly impossible for me to do so. I have, except in this unavoidable deviation from your wishes, endeavored to carry out the instructions conveyed to me. I hope sincerely the course I have pursued will meet your approbation.

I am, sir, very respectfully, your obedient servant,

CHAS. L. TAPLIN,
Assistant on Survey.

Captain JOHN POPE,
Top. Eng., U. S. A., Commanding Exploring Party.

The above received at camp, mouth of Delaware creek, March 18, 1854. For particulars of Mitchell's return across the Llanco Estacado, see page 66. The following is the concluding portion of this report:

SULPHUR SPRINGS OF THE COLORADO,
April 2, 1854.

SIR: I have the honor to submit the continuation of my report from the 16th to the 29th ult:

Thursday, March 16.—This morning Mitchell and the Mexican started. My party now consists of ten men, with seventeen mules. At 11 a. m. went back to the springs and watered our mules; encamped there until 4 p. m., the mules again watered; filled our canteens and started for the wagons. We followed our own trail for six miles and camped for the night. This is a trail evidently used by the Indians, which we followed out, in hunting, ten miles; it no doubt leads to water.

Friday, March 17.—Started at 5 a m., keeping our old trail. At 10 a. m. we discovered our two lost mules, about one mile south of the trail; they were soon caught. We reached the wagons at half-past 5 p. m., and found everything safe. Mitchell left a note stating that he arrived here last night at 5 p. m., and started on this morning; he left us half a keg of water. We have over four sacks of corn, which will be issued to the men as rations. Game wild; nothing killed but a prairie-chicken.

Saturday, March 18.—Started with the wagons at half-past 5 a. m. for the springs. The distance I estimate at forty-five miles. Game scarce; antelope and rabbit killed. Camped at 6 p. m. on prairie; saw a large band of mustangs.

Sunday, March 19.—Dark and cloudy, with thunder and lightning; every appearance of a storm. Could not see the trail until 6 a. m., when we started for the springs; which we reached at 10 a m., and camped half a mile below several ponds, with water running between them. The day misty and rainy; an antelope killed.

Monday, March 20.—Cloudy, with misty rain all night. As yet we have no recent signs of Indians. We, however, keep a vigilant look-out; our mules well guarded. Started at 11 a. m., and followed the ravine down two miles and camped; grass good; scattering mezquite. Here the bed of the ravine widens, and forms a saline bottom of salty grass; the water, which is brackish, stands in holes.

Tuesday, March 21.—This morning it cleared off, the wind changing to the westward. At 11 a. m. moved up to the vicinity of the springs, as the water is brackish here. In expectation of a party from the Pecos, we do not wish to move to any distance from this place for three or four days. Nothing killed; game wild and hard to get at.

Wednesday, March 22.—Watered the mules; filled our kegs and moved out to where there was good grass. One pint of corn issued to the men: this they boil or parch; it is ground in a coffee-mill. No game killed to-day.

Thursday, March 23.—At 11 a. m. moved to the springs. Since the 19th we have lived upon a pint of corn per day, with the game we have killed. The men behave well; no grumbling. Rain and thunder at 10 p. m.

Friday, March 24.—It being the tenth day since Mitchell left for the Pecos, all idea of a party coming across has been given up. We will start to-day for the road, keeping an east course from this place. The mules are well rested and in good condition.

Travelled ten miles due west, and camped in a mezquite bottom; plenty of large, dry mezquite for fuel; no water. We passed two salt lakes to the south of our course; rolling prairie. The oak and mezquite are becoming larger; plenty of grass. Crossed the ravine about five miles below the springs; no water in the bed of it.

Saturday, March 25.—Morning cloudy; misty rain; wind north; not very cold. A high range of hills in sight, a little south of east, about fifteen miles distant. I altered my course towards Marcy's trail, and struck it about six miles from last camp. This trail runs nearly

north and south; followed it for four miles to the south, and encamped between the hills or bluffs for the night. The water is in ponds; plenty of mezquite on the hills; large brush; wild china in the bed of the ravine; also plum and currant bushes.

Sunday and Monday, March 26 *and* 27.—We lay by in camp to rest the mules. It may be of importance to have them in good condition when we meet the command.

The Sulphur Springs are about twenty miles distant from this point, in a northwest direction; we crossed the ravine leading from them at the base of the hills running off to the east, about two miles from this camp. There are large banks of red clay and dirt a short distance down the ravine. About half a mile above this point is the deep chasm spoken of by Captain Marcy, as the "Big Springs of the Colorado." Near them are whole ledges of petrified oyster-shells; the rock is principally lime and sand stone. The spring is at least fifteen or twenty feet deep, and about twenty yards wide. Plenty of wild plum-trees in full bloom; the grass is springing up; trees budding. We have not lately come upon any Indian tracks. Two antelopes and one rabbit killed. Rattlesnakes begin to show themselves in great numbers. Heavy frost last night.

Tuesday, March 28.—Left camp at 8 a. m. for the Laguna, twenty-three miles distant. Passed over a rolling prairie. Saw several dry ponds in low places, where there is evidently water in the rainy season; also some large mezquite and hackberry.

I and Cloud (the hunter,) being in advance of the wagons, saw, as we supposed, some mustangs, but on a nearer approach they proved to be Indians. We stopped until the wagons came up. All looked to their arms, and started to meet them. From the brush and breaks in the hills, we knew it must be the Laguna at which the Indians were encamped. Upon coming to the top of the hill we saw them driving off their horses in a northwest direction. Two of the Indians came towards us. Their interpreter, a Mexican, who said he was taken captive when a boy, stated that they were a stealing party of Kioways, returning from Mexico with a large band of horses, colts, and mares. We saw but fifteen of this party. The interpreter said there was a larger one coming up to-night, principally on foot. As they were hungry, we gave them a few pints of corn.

Moved on to the Laguna. Having watered our animals and filled our kegs and canteens, we proceeded farther, and encamped on the open prairie. The Indians fired the plain as they went off. This signal was immediately answered by a fire about three miles distant to the south.

In an hour we perceived the party spoken of by the Mexicans. Some of them were driving their loose animals off towards the lake; but the principal part (twenty-three in number) came to us. There were three of them mounted, and these on miserable animals. One of the Indians rode ahead displaying an old white shirt, intended as a flag; it certainly was not a white flag. Our mules were tied to the wagons, the men standing to their arms. The Indians having been told not to come near the wagons, sat down in a circle and commenced begging, as usual. We gave them a little corn. They started for the lake, where their animals were driven. As soon as it was dark we geared up and moved about four miles, and encamped. The wagons were driven close together, the animals tied to them. Kept a good look-out.

Wednesday, March 29.—At day-light turned our mules out to graze; geared up at 8 a. m. and started on. At 10 p. m. perceived a party ahead of us, which proved to be the command. Three kegs of water which we had along were of great service to them. It gave me much pleasure to report the recovery of the missing mules.

I cannot conclude without bringing under your notice the excellent conduct of the men under my charge. It was highly praiseworthy; each man aiming to assist and aid his comrade. All bore the hardships which we unavoidably encountered with cheerfulness and good temper.

It now only remains for me to reiterate my hopes that the course I have pursued, in the execution of your orders, will receive your approval. I am, sir, very respectfully,

CHAS. L. TAPLIN, *Assistant on Survey.*

Captain JNO. POPE,
Top. Eng., U. S. A., Commanding Exploring Party.

Same Camp—Monday, April 3, 1854.—The following is a topographical outline of the country from the Mustang Springs to the present camp. For about eight miles after leaving the Mustang Springs, we continued to travel a road of the same character as we had previously; at this distance we descended a bluff of fifty feet, to a level valley about seven miles across. The valley, at its northwest extremity, contains a chain of salt lakes, which have a course a little south of east, their outlet passing only a mile and a half east of the Big Springs of the Colorado, which are tributary to it. At the northern extremity of this valley, also, the outlet to the Sulphur Springs of the Colorado joins this chain of salt lakes.

The Big Springs of the Colorado issue from a ravine on the northeast slope of a range of hills, 200 or 250 feet high, whose general direction is south 45° east; at a distance of one and a half mile the outlet of the springs joins the valley of the salt lakes, and becomes, at this point, dry. Many of these lakes contain water, the beds, when we passed, being moist, the water totally unfit for use.

An Indian trail leads from the Sulphur Springs of the Colorado, in a southwest direction, to the Mustang Springs, and from them to the Horse Head crossing of the Pecos. It also extends in a northeast direction from this point to the head of the Brazos. This trail is a very broad and deep one, and is evidently in constant use by the Indians in their forays into Mexico. It leads, undoubtedly, along the eastern base of the Llano Estacado, and connects the extreme western permanent watering-places. From the position of this trail, and the character of the country to the northwest of the Sulphur Springs, there can be no question that this is the nearest water to the Pecos in the direction of Delaware creek. The Kioways whom we met, as already mentioned, came by a trail from the Horse Head crossing to the Mustang Springs, and continued their journey homeward to the Arkansas by the same trail, passing the Sulphur Springs.

The Sulphur Springs of the Colorado, five in number, issue from one side of a ravine, the water of one spring tinged slightly with sulphur; the remainder contain pure and fresh water, which holds a small portion of lime in solution. Below the springs there is a large pond, where animals can be watered with much ease. The east side of this ravine is composed of layers of limestone, which is found to be mixed (in a decomposed state) with the surrounding soil. The grass is young and good; it is eaten with much avidity by the animals. Our wood (mezquite-root) is obtained in abundance by sending wagons a couple of miles from camp for it.

Our animals are out grazing all the time—loose during the day, but hobbled at night. Two horses and two mules are held in hand all day, so as to be in readiness in the event of a stampede, or other emergency requiring their use. There is a strong guard placed over them day and night; they are constantly moved about to fresh grass.

Rattlesnakes are abundant; we have killed several, some of them of a monstrous size.

The soil is good clay, mixed with gravel. The country on all sides around us presents a nearly unbroken level, covered with a young growth of short and nutritious grass.

No observations taken during the day or at night.

Same Camp—Tuesday, April 4, 1854.—Lieutenant Garrard left camp this morning at 6 o'clock to survey and take the levels of the Llano Estacado from the falls of the Pecos (our former camping-place) to this point. His party consists of three mounted men and an ambulance driver, one ambulance with four mules, three riding and six pack-mules, supplied with nine days' rations, and two sacks of corn; the six mules were packed with two kegs of water each.

The lieutenant was accompanied as far as his first camp, thirty-five miles from this place, by three men, and six mules packed with two kegs of water each; six of these kegs were used at the point last mentioned, in watering the mules destined to cross the jornada, and six left there to be used (for the same purpose) on their return from the Pecos. This last party are to start for this camp on the morning of the 5th. It was not deemed judicious to send a large party across, the difficulty of providing a sufficiency of water for a larger number being very great. It is hoped that this arrangement will prevent much suffering to either men or animals.

We anticipate that the lieutenant will join the command in about nine days. The animals herded, &c., the same as usual. No observations taken to-day.

Same Camp—April 5, 6, *and* 7, 1854.—The weather is very changeable, the days being exceedingly warm, the mercury rising as high as —, the nights and mornings cold. One day the thermometer rose —° in a few hours. There is, however, always a good breeze. For nearly the first time since we left Doña Ana, we are free from dust and sand. No one can truly appreciate this luxury but those who have encountered the clouds of sand by which the traveller is blinded, choked, and literally overwhelmed, on the banks of the Rio Grande, and throughout nearly every portion of this country. We appear to be getting rid of this frightful nuisance.

The same arrangement continued respecting the animals.

Extensive astronomical observations taken during these days. The party that accompanied Lieutenant Garrard to his first camp returned on the 5th, at sundown.

Same Camp—Saturday, April 8, 1854.—Captain Taplin left the command this morning at 7 o'clock, with instructions to examine the country in advance of the train for about sixty miles. He was accompanied by four men of the escort and six of the topographical party, all mounted, with one pack-mule carrying four days' rations.

The command in camp employed in repairing wagon, herding, &c.

Same Camp—April 9 *and* 10, 1854.—The weather still continues warm in the day, cold nights and mornings, with occasionally strong winds. The absence of a large body of water prevents the atmosphere from becoming damp and humid; if it were otherwise, it would be insupportable.

All are wishing for the word to start on our way, though the camp is good and supplied with every requisite. All are more or less anxious to move forward. The level plain with which we are surrounded as far as the eye can reach, without a single brush or tree to break the monotony of the scene, is truly wearisome.

Animals grazed and herded as usual. Extensive astronomical observations taken these days.

Same Camp—April 11, 1854.—Captain Taplin and party returned to camp at 1 p. m. His report of the country ahead of us is highly favorable. He found, first day's march, water in holes twenty miles from camp; next water fourteen miles farther; from this point until the termination of the second day's march, it is about four miles from one watering-place to another. The whole distance travelled by this party was sixty-one miles. Mezquite and hackberry plenty at, or convenient to, all the watering-places. Grass generally good. Most of the ravines on this route lead to the southeast. Lieutenant Garrard and party arrived in camp at 5 p. m. He reports the distance from the fall of the Pecos, mouth of Delaware Springs, to this camp, to be one hundred and twenty-five and one-tenth miles, and north 70° east. His report of the Llano Estacado varies so little from the statement of Captain Taplin, that a reference to the latter will answer every purpose as to the character of the country, vegetation, &c. Neither the party nor the animals showed much sign of suffering; the one being in good spirits, the other (taking all things into consideration) in very good condition; the arrangements for their comfort and convenience proving successful.

The surveying of this dreaded Llano is now accomplished; its reputed horrors, by no means exaggerated, have been overcome; it has been crossed safely by two of our parties without loss or suffering. This jornada is no longer a sealed book; we have now a thorough and practical knowledge of it in every respect. Everything considered, we have reason to congratulate ourselves upon the successful termination of this important portion of our survey.

Lieutenant Garrard and Captain Taplin having arrived, orders were issued to the command to start on the following morning.

The animals that crossed the Llano fed with corn. The same arrangement regarding the mules continued. Observations taken during the day and at night.

Camp No. 34—*Wednesday, April* 12, 1854.—Left camp at twenty minutes to 11 a. m., and

followed the Indian trail, (already mentioned;) but as it bore too much to the north, we turned off it at two miles from camp, and proceeded more to the eastward. We also left the route pursued by Captain Taplin for a similar reason, taking a direct course for our destination, Preston. For the first three miles our route was sandy and heavy; the country considerably broken by ravines and gullies. On advancing, our road was over a hard and firm ground. The prairie is directly eastward of the Llano Estacado; it is level and well defined, and covered with a short thick grass, which the animals eat with much avidity. The mezquite-tree is most abundant. There can be little doubt that during, or immediately after the rainy season, water can be obtained in the numerous holes along this road.

The soil is good clay, mixed (slightly) with gravel, producing a variety of flowers. This, with the fresh and green appearance of the landscape, forms a pleasing contrast to the parched and arid prairie that we have generally been traversing. Antelopes and rabbits plenty; the former are so shy, they are hard to get at.

The day was warm, but tempered by a pleasant breeze. We encamped at fifteen minutes to 3 p. m., without water. This was not felt, as our mules had been watered before starting and our kegs filled. Mezquite abundant; grass good.

The mules we turned loose (unhobbled) until sundown; then drove in, hobbled, and turned out to graze during the night. Four animals kept picketed in camp, in case of emergency. A strong guard over them, as usual.

No observations taken during the day or at night. General direction, north 55° east; miles, $11\frac{4}{10}$.

Camp No. 35—*Thursday, April* 13, 1854.—Left camp at five minutes to 7 a. m. Our route for about three miles continued over a level and excellent prairie. We then began to descend into a wide and pleasant valley. Our road was diversified by numerous gentle undulations. Having proceeded about eight miles, we came to a deep ravine, in which we found water. At this place we nooned for nearly two hours; the animals were plentifully watered, and turned loose to graze; our kegs were filled. There is excellent grass here, besides a description of wild Timothy grass, which the mules ate greedily. The water is neither good nor pure, except in one or two holes, tasting strongly of weeds. The mules being hitched up, we proceeded upon a nearly level prairie. We now perceived to the north of our course, about eighteen miles distant, a high mound and some bluffs, where we suppose the Colorado takes its rise. The prairie is slightly rolling, and covered over with white and yellow flowers, emitting a fragrant perfume. The mezquite is green and grows in the utmost profusion; indeed, one is cheated into the belief that he is passing through an orchard. This is the only growing timber we have seen since we left the Pinery. The sloping banks are clothed with violets, adding to the variety and pleasure of the scene. The soil changes its color, and becomes a deep red; it is good firm clay, mixed with sand. Saw plenty of antelope and deer, but did not succeed in getting any. The Doctor shot a "bird of paradise;" its plumage is of the most exquisite delicacy and color.

The day was not so warm as usual, but pleasant for travelling. We had an excellent road the whole day, and reached camp at fifteen minutes to 4 p. m. No water; mezquite wood in abundance; grass good.

The usual arrangements in respect to the animals continued.

No observations taken during the day or at night. General direction, north 70° east; miles, $15\frac{1}{10}$.

Camp No. 36—*Friday, April* 14, 1854.—Left last camp at ten minutes after 6 a. m., and resumed our course over a rolling prairie. The mules were fresh, and travelled well, our road being firm and good. We nooned for about two hours, at eleven miles from last camp, on the banks of an arroyo, where we watered the animals, and filled our kegs. During this day's route we passed five arroyos: two of them contained water; the remainder were dry, but had every appearance of having lately contained water. These ravines are generally rugged and

steep; we did not experience, however, much difficulty in crossing them. They run off in a northeast direction towards the mound and bluffs already mentioned, and eventually fall into the stream on the banks of which we camped, supposed to be one of the forks of the Colorado.

The soil passed over to-day is good red clay and sand; we came upon two or three gravelly places. There is an abundance of mezquite trees and roots; the former growing same as yesterday. The grass is green and abundant. Wild flowers are scattered profusely over the plain. Saw a number of antelope; killed one. Reached our camp on the Colorado fifteen minutes after 4 p. m. Its banks are very steep; the water is running, and not deep. This encampment is about fourteen miles south of a mound and bluffs we saw yesterday, and which continue in sight throughout to-day. There is a plenty of mezquite and some hackberry; water brackish. In the neighborhood of camp there are many mounds of red sand; the tops and sides covered with red sandstone in great profusion. On the summit of these hills we found fossil sea-shells and portions of petrified trees: these hills stand apart from each other; one of them assumes the form of a pyramid. There is plenty of game here.

Animals grazed loose till sundown; then driven in, hobbled, and turned out for the night, as usual—under a strong guard.

No observations during the day; observations for time and latitude taken at night. General direction, north 70° east; miles, $18\frac{2}{10}$.

Camp No. 37—*Saturday, April* 15, 1854.—Left last camp at fifteen minutes after 7 a. m., and crossed the Colorado about four miles from camp, at the base of a red sandstone bluff. The banks were steep and rocky. After some labor, a very good crossing was made. The banks were cut down on both sides, and the rocks being thrown along the bottom, made it firm. The stream was narrow and shallow; the sides of it are of good firm clay.

Having effected a safe crossing, we ascended a high rolling prairie, passing over two deep arroyos—one dry, the other with a stream of clear running water, which empties itself into the Colorado. The sides of these arroyos are steep, but we succeeded in crossing them without much difficulty. We encountered several ravines on our route, but none of them of a formidable character. A portion of our road (about three miles) was heavy sand; with these exceptions it was excellent.

The soil is good clay, of a red color, mixed with gravel. The mezquite-tree still continues abundant. Scrub-oak is beginning to appear in considerable quantities. The grass is generally good, except in the vicinity of the sand, where it becomes coarse and scanty.

We nooned for two hours at the arroyo mentioned above as having the running water. Our animals were watered here, and as we were uncertain of finding water at night, our casks were filled.

When within a couple of miles of camp for the night, we met a party of Camanches. We halted, and two of them approached us with a white flag. Immediately after the whole party came up, headed by a most outré looking figure. This was Sanchoz, one of their chiefs, dressed in an infantry captain's uniform coat, silver epaulets, red sash tied over his shoulder, nondescript pantaloons, and moccasins: add to this a military cap with an enormous red pompon, and some idea may be formed of an exhibition at once ridiculous and humiliating. This man, who is rather old, has an intelligent countenance and piercing eye. The party consisted of about seventeen in number; five of them were squaws, whose appearance was not very fascinating. One of them had a "muchecho" on the saddle before her. Through their interpreter (a Mexican captive boy) we learned that they had been to Fort Chadbourne, and were going to hunt wild horses. The women rode *à la mode des hommes.* They all had good horses; indeed some of their animals were beautiful and in high condition. After the usual embracing, and the customary vows of eternal friendship, the chief, though so well-dressed, commenced begging. We gave them an ox. They then departed, as we devoutly hoped; but some of them came afterwards to our camp *in time for supper.* They were told not to come near camp after night-fall.

Reached camp at half-past 4 p. m., near a ravine, with water, running southeast. Water not good; grass excellent; wood abundant. Same arrangement continued regarding the animals. The vicinity of the Indians put all hands on the *qui vive*. No observations taken during the day or at night. General direction, north 70° east; miles, $12\frac{1}{10}$.

Camp No. 38—*Sunday, April* 16, 1854.—Lieutenant Marshall, accompanied by five of the topographical party and five soldiers, all mounted, with two pack-mules and four days' rations, started at half-past 6 a. m. for Fort Chadbourne, to get some articles necessary for the expedition, and also to explore the rivers, &c., in that direction. He will join us in four days on the Brazos river.

Left camp and crossed the ravine, and proceeded over a good rolling prairie. We crossed also, in a short distance, two dry ravines. At about six miles distance we passed over the most eastern tributary of the Colorado. The banks of this stream are thickly covered with timber—mezquite, hackberry, wild china, plum, willow, and scrub-oak. It contains an abundance of fish—trout, buffalo, catfish, sunfish, perch, and bass. We caught a great many of them. The stream is deep; the water beautifully clear and fresh.

We had to cut down the trees on both banks, and level them a little, to allow our wagons to pass. This, however, did not cause much delay or trouble. We nooned here for two hours on excellent grass. We then moved forward over a firm prairie, and camped at half-past 5 p. m. on the "dividing ridge between the Colorado and Brazos rivers," on a dry bed of a stream which runs into the latter. No water; wood and grass in abundance.

The country still continues to improve. The trees assume a greater variety, and are of a larger growth. The grass is good and short; speaking generally, it is of an excellent quality. The scenery is varied and pleasing. The plain, clothed profusely in many places with flowers, looks quite fresh and gay. Our animals travelled well, and looked in excellent condition; same arrangement in respect to them as usual. Observations for time taken in the day; none at night. General direction, north 71° east; miles, $16\frac{2}{10}$.

Camp No. 39—*Monday, April* 17, 1854.—Left camp at half-past 6 a. m., crossing the dry bed of the creek on which we camped. After proceeding about five miles over a very rolling country, we struck Marcy's trail; crossed and left it to the north of our route. One mile farther we came to a stream of running water; this is a tributary of the Brazos, and a continuation of the ravine we passed in the morning. This stream has an abundance of trout, bass, sunfish, and catfish. We caught some of them. A moccasin snake was killed on the bank. This reptile is as poisonous as the rattlesnake, and more dangerous, as it gives no warning before attacking.

All of our animals were plentifully watered, and our kegs filled. We nooned about two miles from this water for a couple of hours, on a dry bed of a ravine, which, though somewhat steep, we crossed without difficulty. From the summit of a ridge the country to the eastward appeared much broken, and difficult to travel; we found, however, that it was not so bad as it appeared. Reached camp on a tributary of the Brazos at 15 minutes after 4 p. m.: there was water here, but it was brackish and bad; the mules drank it freely; wood and grass in abundance. The soil passed over to-day is excellent; mezquite, hackberry, and scrub-oak abundant: the former attains a large growth. The grass is also excellent, particularly along the sides and bottoms of the ravines. Vegetation is very forward; the face of the country improves as we proceed. We have lately obtained some curious petrifactions—particularly some petrified teeth of an enormous size, belonging to an animal unknown to us. Mules grazed, &c., as usual. No observations taken during the day; some at night, for time and latitude. General direction, north 70° east; miles, 16.

Camp No. 40—*Tuesday, April* 18, 1854.—Left last camp at 20 minutes after 6 a. m., and proceeded over a fine rolling prairie; passing many dry ravines. At about six miles from camp we came to a tributary of the Brazos—it had good water. The banks on both sides had to be cut down; the wagons passed over safely. All the ravines we crossed yesterday after-

noon run into this stream. The gypsum formation here is somewhat analogous to that of Delaware creek. Our animals were watered, and our kegs filled. We resumed our route over an undulating plain, and three miles farther came to another tributary of the Brazos ; the banks here had also to be cut down. The water in this ravine is intolerably saline. We nooned here for about two hours ; turned the animals out to graze. Having proceeded about fifteen miles, we intersected a wagon trail, running north and south ; this is supposed to be a trail from some of the upper posts or towns in the northern part of Texas to Marcy's trail. We saw a trail which had evidently been traversed by a large party of Indians. Our route to-day was over a fine country in every respect. We had timber of a great variety, and tolerably large growth ; in fact, if the timber in this section of the country was not stunted in its growth by the constant firing of the prairie, there could not be a better timbered country. We found mezquite, oak, china, cotton-wood, &c., of a pretty large size. Reached camp at half-past 4 p. m., on the dry bed of a ravine ; wood abundant ; grass not so good as it has been. Immediately before coming into camp we encountered some heavy sand. No water at camp. Animals grazed, &c., as usual. No observations taken. General direction north, 60° east ; miles $17\frac{6}{10}$.

Camp No. 41—*Wednesday, April* 19, 1854.—Left last camp at 15 minutes after 6 a. m. ; continued our course over an excellent road, and through a fine country. We did not encounter so many ravines as we had for some days previous ; crossed two having a northerly direction. After proceeding twelve miles, we descended about thirty feet from the plateau to a level plain. The face of this descent is composed of limestone and red sandstone—the former in horizontal strata ; decomposed gypsum was pretty thickly scattered around. A little to the south of where we descended the bluff is nearly 100 feet high, and nearly perpendicular. The country continues well wooded, with grass in abundance. It is to be observed that the mezquite-tree is the principal growth—oak, cotton-wood, &c., scarce. Our road to-day was good and firm ; one or two places, some little sand. Found no water until we camped, at 15 minutes after 1 p. m., on a ravine running northeast. This water is strongly impregnated with gypsum, tasting bitter ; it appears to be permanent ; it is best where the rocks are thickest ; it was very saline in some holes which we dug. Wood abundant ; grass excellent, both prairie and grama. Animals grazed, guarded, &c., as usual. No observations taken ; the day and night cloudy, with every appearance of rain. General direction, north 60° east ; miles, $18\frac{1}{10}$.

Camp No. 42—*Thursday, April* 20, 1854.—Left camp at 20 minutes to 7 a. m., and crossed the ravine upon which we camped. We continued our course through a fine, well-wooded country, over a hard, firm road. The appearance and character of the country is somewhat similar to that of yesterday. Having passed a dry ravine, at $11\frac{6}{10}$ miles we came to a creek with tolerable water, at which we nooned ; the water was rather scarce, but much better than where we stayed last night. Our animals were watered, and turned loose to graze for two hours. The bed of the creek is muddy and miry ; the banks are steep. This creek must have a very rapid and deep current during the rainy seasons. Here, for the first time since we started, we found a considerable growth of elm. This tree, though it grows here tolerably large, yet does not attain the size to which it arrives in the States. Its thick foliage makes a pleasant shade from the heat of the sun. We saw on the banks what appeared to have been a dragoon camp ; it must have been made two years since, probably by a scouting party.

Before nooning we started a wild turkey, which afforded a capital "run"—some of our best animals were immediately after him. For a little time the chances for his escape seemed highly probable ; the poor fellow scampered off in great style, baffling all pursuers but one, a Mexican, named José, who lassoed or lariated him. The bird succeeded in slipping through the noose. This rather novel proceeding seemed to astonish him (the turkey) so much, that he lost his presence of *mind*. However that may be, he certainly lost the use of his legs, was captured, and brought into camp amidst acclamations—his beautiful plumage exciting the utmost admiration. This bird weighed $16\frac{3}{4}$ pounds. The mules being hitched up, we found a good crossing and passed the stream safely.

Reached our camp, on a tributary of the Brazos, at ten minutes to 4 p. m. Wood and grass good and abundant; the water is nearly the same as where we nooned; both are somewhat tinctured with gypsum. Capital timber along its banks; the elm predominates. Altogether, it is a charming camping-ground. Wild turkeys abundant. For the last two days we have made a considerable descent, but it has been very gradual.

We had some hopes that Lieutenant Marshall would join us to-day; but we were disappointed.

Mules grazed and herded, &c., as usual. Day cloudy; no observations taken; observed at night for time and latitude. The streams mentioned above bear to the north. The weather continues warm, with a pleasant breeze. General direction, north 60° east; miles, $17\frac{4}{10}$.

Camp No. 43—*Friday, April* 21, 1854.—Left last camp at fifteen minutes to 7 a. m., and proceeded on our course, parallel to the creek on which we camped, for one and a half mile, and crossed it. This is a thickly-timbered stream, with steep banks and soft bottom; water not running. We had to cut down the banks and some of the trees on both sides; filling up the bottom, we were then enabled to cross. At eight miles from camp we descended into a valley, and nooned near some permanent water. The sides of the ravine continuing in it are sloping and rocky. The country in the immediate vicinity is not so fertile as that we have been passing. There is here a pond or spring of excellent water, abounding in fish, many of which we caught. Our animals were watered and turned loose to graze for two hours. Near this place we intersected a well-defined wagon trail running north and south, evidently used by traders from Texas in reaching Marcy's trail.

We resumed our course over a rather rough and rolling prairie, following the last ravine to its mouth until we struck another tributary of the Brazos. This stream runs along the base of a high bluff. We followed the valley, which is narrow, along its banks; our road was between the bluff and the stream; we were obliged to cut our way through the thick timber: this, nearly always a tedious process, did not cause us much delay. We camped on the bank of the stream at fifteen minutes after 4 p. m., in the only open place we found. The water is pure and clear; the bottom firm. Catfish, sunfish, buffalo, trout, garr, &c., abundant; grass good and plenty. This whole valley is extremely heavily timbered; brush and small trees thick. The streams passed to-day have a northeast direction.

In preparation for to-morrow, some trees were cut down on both banks, and a capital crossing made.

The country we traversed to-day is, except in the instance above mentioned, nearly similar to that we have been travelling for some days.

The weather is exceedingly warm, the mercury rising as high as ninety-eight degrees in the shade. There is, however, always a breeze, which tempers the heat, so that it is not absolutely intolerable.

Mules herded and grazed as usual. No observations taken during the day or at night. General direction, north 60° east; miles, $12\frac{8}{10}$.

Camp No. 44—*Saturday, April* 22, 1854.—Left last camp at fifteen minutes after 6 a. m., crossing the stream where we cut down the banks and trees the previous evening. We were obliged to cross it three times. The narrow valley on its banks is bounded on both sides by bluffs and steep ascents leading to a high table-land. The stream running in a zigzag course, required us to deviate considerably from our line, in order to avoid the many formidable obstacles presented by the numerous elevations and ravines. We had to cut our way through, with a great deal of labor. We encamped at 12 o'clock noon on its banks. This tributary—the Clear fork of the Brazos—is here a large stream, heavily timbered, about twenty-five yards wide, and very deep; the water is excellent, and abounds in fish. Wild turkeys visit this place in great numbers to eat pecan nuts, of which they are fond. Grass excellent, particularly along the bottoms.

It was concluded to halt here for a day or two to take some astronomical observations, and also to await the arrival of Lieutenant Marshall and party.

Having been cloudy all day, the night was ushered in by a violent storm of wind and rain. It was the only rain we experienced since we started.

Animals herded, grazed, &c., as usual. No observations taken during the day or at night. General direction, north 40° east; miles, $6\frac{6}{10}$.

General remarks upon the country from the Sulphur springs to the Clear Fork of the Brazos.—Between the Sulphur springs and the dividing ridge of the Colorado and Brazos we passed over a country generally well timbered with the mezquite. The country is generally rolling for this distance. Between the Sulphur springs and the main Red fork of the Colorado it is intersected by ravines, of easy ascent and descent, tributary to the Colorado, having a course about north-east. We found an abundance of water at distances of from three to ten miles; we passed it during the dry season, and no doubt water can be always obtained. The Red fork, or main stream of the Colorado, (almost forty-four miles east of the Sulphur springs,) runs in a very zigzag course to the southeast, through a valley about one and a quarter mile in width, bordered on both sides with red sandstone bluffs, from which an easy ascent can be had to the stream at any point.

The immediate bed of the stream is about twenty feet in width, with miry bottom and perpendicular banks ten feet in height; rendering its pass up for wagons, except at particular points, very difficult. The water, which is slightly brackish, is found in pools or holes connected by a swift-running stream. From the main Colorado to the dividing ridge between it and the Brazos (a distance of $28\frac{3}{10}$ miles) we encountered two principal tributaries, both having rocky and gravelly beds, with pure water and a considerable growth of timber. The route passed over a gently-rolling country, firm and hard, having an abundance of grass, intersected with many ravines of easy ascent and descent, tributary to the main stream, and running in a southerly and southwestern direction. The country is similar in all respects, except in having a greater growth of mezquite timber, to that on the west of the Colorado.

The dividing ridge (between the waters of the Colorado and Brazos) is elevated probably 100 feet above the Colorado, and from the head of the most easterly tributary to that stream, along the route, to the first tributary of the Brazos, is a fine high plain about $1\frac{1}{2}$ mile in width. About five miles east of this dividing ridge we crossed Marcy's trail and the first tributary of the Brazos, (supposed to be a tributary of the Double Mountain fork;) from thence to a small tributary of the Clear fork of the Brazos we passed through a country generally level, and most of the way through a thick forest of mezquite timber. The only break in this line of country occurs between a tributary of the Clear fork and a tributary of the Brazos: a high mesa or table-land lies between them; descending from which, in the exact line of our route to the eastward, a descent of about 100 feet presents itself. This is easily avoided by passing about a mile to the north. The first tributary of the Clear fork, which we struck at a distance of —— miles from the supposed Double Mountain fork, is about 20 feet wide, banks 10 feet high, having a very tortuous course to the southeastward, through a level plain bordered on the east side by a low ridge of sand about $1\frac{1}{2}$ mile across. The waters of this stream are in many places quite salty. The principal stream, which runs between this point and the Clear fork, is a much larger one, and is tributary (in a northeast direction) to the main branch of the Brazos; has abundance of timber, elm, hackberry, and other trees; and traverses, in a very zigzag course, a beautiful and fertile valley, about three miles in width, bounded by very gentle elevations, covered by forests of mezquite.

The Clear fork of the Brazos is a large stream, heavily timbered, about 20 yards in width, and in many places 10 to 15 feet deep; very pure and clear water. The stream runs in a zigzag course, through a very narrow valley or cañon, with rocky bluffs about 150 feet high, and the surface of the stream is about that distance below the general level of the country.

The country along these tributaries of the Brazos is in all respects superior to that of the Colorado, and the whole of it as fine farming and stock-raising country as can be found in the world.

CHAPTER IV.—*From Clear Fork of the Brazos to the Valley of the Red River.*

Same Camp—Sunday, April 23, 1854.—Lieutenant Marshall joined the command this morning at 9 o'clock with his party; all well. The animals were in tolerable condition, considering the journey they had made. He found Fort Chadbourne to be about seventy-five miles distant from the point where he left us; (see journal of the 16th instant.) This post was commanded by Assistant Surgeon Swift, U. S. A., all the other officers being absent on duty, and was garrisoned by two companies (F and C) second dragoons, both of which were out scouting. The lieutenant brought us some newspapers and books, from which we gleaned some items concerning the sayings and doings of the busy world. The command passed the day washing, swimming, fishing, &c., for which the stream afforded all facilities. All necessary repairs to wagons, &c., were made, and our specimens packed in a more commodious manner. For the last few days we have added considerably to our collection of birds and fishes. To-day we succeeded in catching a pole-cat, or skunk. It is a fine specimen, and required the use of only one of the senses (smelling) perfectly to inform us of his vicinity. We also caught a garr-fish; this fish we had not seen until we struck the Clear fork. It is of a bright yellow color, and enveloped in a hard, scaly covering, more like shell than cuticle. It has a long pointed head, armed with a numerous and formidable set of teeth, well adapted for seizing and holding its prey. As before remarked, this stream is very heavily timbered with mezquite, hackberry, elm, oak, pecan, cotton-wood, &c.

The appearance of the country about our camp is of the most picturesque and varied character. The animals grazed in the bottoms, where the grass is excellent and abundant. The day was warm; the earlier part of it being cloudy. The night set in with a violent thunder-storm; the rain poured down heavily till about 2 a. m. In consequence of the unfavorable state of the weather, no observations could be made during our stay at this camp.

Camp No. 45—*Monday, April* 24, 1854.—Started at half-past 7 a. m., and ascended a high table-land, traversing a very rolling and broken country. The summits of the ridges we passed over were very rocky, with some abrupt descents. We crossed many of the heads of ravines which run into the Clear fork, but they did not present any serious obstacle. Having proceeded about eight and a halt miles, we struck the military road which connects Preston, Forts Belknap, Chadbourne, Phantom Hill, and San Antonio. We nooned at a short distance from this point for about two hours; we commenced descending somewhat abruptly until we reached a most beautiful valley.

Before reaching camp we perceived a log-house and farm. It requires an absence as long as ours from all human habitations to realize the sensation this sight created. On arriving at it we ascertained that it, with about twenty-two hundred acres of the surrounding valley, had belonged to Col. Jefferson Stem, Indian agent, who was murdered by two Wichitas on the 12th of February last. The perpetrators of this outrage were seized by some friendly Camanches and killed. The Colonel was from Tippin, Seneca county, Ohio, and was a lawyer by profession. This farm, though not long under cultivation, produced last year five thousand bushels of corn.

We also encountered here a party of California emigrants, with a considerable amount of stock and animals. They received such information from us as will, no doubt, be useful to them on their journey.

Camped in the valley at 4 p. m. on a rivulet which flows into the Clear fork of the Brazos. We are now thirty-five miles from Fort Belknap, and intend following the road if it does not deviate much from our exact route. The country passed over to-day is well timbered, but not so fertile on the high-lands as that we have been traversing. At camp we had excellent grass,

wood, and water; mules grazed and herded as usual. Observations at night for time and latitude.

Camp No. 46—*Tuesday, April* 25, 1854.—Left last camp at ten minutes after 6 a. m., and continued our route along the military road through a rolling country. The road is excellent, and, in consequence of the dryness of the season, is firm and hard. The animals being in good condition, travelled well. We were obliged to deviate slightly from our direct course, to avoid some difficult places. During this day's march we descended considerably, but gradually. The soil all through is excellent; the mezquite, oak, and other trees abundant, and of a large growth; the grass young and nutritious. Having proceeded about eleven miles, we nooned at a spring near the road for about two hours; animals turned loose to graze. We then resumed our route over a country similar to the above, and encamped at half-past 4 p. m. near a ravine containing rain-water, of which there was an abundance for the animals, cooking, and other purposes. The whole section of country is covered over with grasshoppers, in countless myriads. They were very troublesome, and at night they completely filled our tents. They appear to be going south; and if they do so increasing in strength and numbers, an incalculable amount of injury will be inflicted on the farmer. The day was remarkably warm. Our near approach to the States, and the beauty of country through which we are passing, have the effect of increasing the good humor and high spirits of the command. Good health and temper are the order of the day. No observations made; mules hobbled, grazed, and herded as usual. General direction, north 65° east; miles, $18\frac{7}{10}$.

Camp No. 47—*Wednesday, April* 26, 1854.—Left last camp at five minutes to 6 a. m., and continued our course travelling the military road. The country is still rolling, with a good soil, and heavily timbered—mezquite, oak, hackberry, &c., of a large growth; grass excellent, and abundant. We continue to descend gently. There is rain-water along the road, at short distances, in holes and ravines. For the last two days we have added to our collection of birds and reptiles. Having travelled eleven miles, we nooned for about two hours in a delightful shade formed by large trees, near some water. We resumed our route over a country same as yesterday.

Lieutenant Marshall, with two men of the party, left the command early in the morning for Fort Belknap, to procure some necessary articles. He joined us a little after sundown, accompanied by Lieutenant McIntire, seventh infantry, and Assistant Surgeon Vollum, U. S. A. The fort is garrisoned by two companies of the second dragoons, and two companies of the seventh infantry, and commanded by Major Steen, second dragoons. Reached camp at twenty minutes after 3 p. m. It is a beautiful camping-place. The rain-water is in ravines near our camp.

We are one mile from the crossing of the Brazos, and about two from Fort Belknap. The day has been excessively warm and sultry. Observations for the time and latitude made. Mules grazed, &c., as usual.

Along our line of March to-day there were perfect groves of post-oak, which is a very valuable timber for many purposes. Scrub and live oak are also in abundance. General direction, north 34° east; miles, $16\frac{4}{10}$.

Camp No. 48—*Thursday, April* 27, 1854.—Left last camp at fifteen minutes to 6 a. m., and moved to the crossing of the Brazos. We passed over without the slightest difficulty, the water not reaching higher, in its deepest place, than the mule's knees. The river at this point is seven hundred feet from bank to bank, which are gently sloping. Its bed is gravelly and firm, and the water is very salty. From the swiftness of the current (even with the small body of water we crossed) there must be a rapid and violent current when the river is swollen.

At a short distance from the river we came to Fort Belknap. This post is beautifully located in a finely wooded country, but is in a very unfinished and scattered state. There is here a steam saw-mill; but being out of order it is useless, the machinist not being competent to make the necessary repairs. The gardens for vegetables, &c., were in a flourishing condition.

Captain Pope and Lieutenant Garrard remained a short time at the post, sending forward

the train, which took the wrong road. When the mistake was discovered, the wagons were surrounded with brush and timber. We, however, rectified our error, and regained our correct road without much trouble.

We camped at 12 o'clock noon on a stream of good running water, over which there is a wooden bridge; grass and wood in abundance.

We travelled through a densely wooded country; post and live oak, large mezquite, &c., in profusion. We saw several small trees of the prickly-ash, and some large cotton-woods. The grass along our route was excellent. Rain-water plenty in holes.

The day was not so warm as usual; the wind changed to the north, and (in the earlier part of the day) was very chilly.

We hoped to obtain some corn at Fort Belknap, but we could not obtain any in consequence of the extreme difficulty of supplying the post. The article is very scarce. It has to be transported from Preston, a distance of two hundred miles. The dragoon horses are allowanced to twelve ears of corn per diem.

Many of the mules were shod to-day, as their feet are getting tender from travelling on the hard road.

There are extensive coal-mines in the neighborhood of Fort Belknap. This coal is used at the post. It is needless to enlarge upon the importance of this fact.

Mules herded and grazed as usual. No observations made; cloudy during the day, and very hazy at night. General direction, north 25° east; miles, $10\frac{9}{10}$.

Camp No. 49—*Friday, April* 28, 1854.—Left last camp at five minutes to 6 a. m., and resumed our route along the military road. The country is similar to that passed yesterday, but somewhat more open. It is gently rolling. There were along our course large and dense groves of oak of a very considerable size. The mezquite is also large and abundant. The soil is capable of the most extensive cultivation. There can be little doubt, from the appearance of the country, that there is sufficient rain for agricultural purposes. Though the season up to this time has been a remarkably dry one, yet the innumerable pools along our route are generally filled with water; indeed, when the earth is dug to the depth of twelve or eighteen inches, it is found to be damp and moist. Dew falls heavily. These remarks apply in general to the country we have passed since we struck the first (western) tributary of the Brazos. Nature has been prolific of her favors to this charming section of country. Having travelled about ten and two-tenths miles, we nooned for two hours in a delightful shade.

About three miles from last camp we crossed a running stream with very steep banks—the last eastern tributary of the Brazos. Six miles farther we surmounted the dividing ridge between the Brazos and Trinity rivers. This ridge slopes gently on both sides. Reached camp at half-past 3 p. m., near a stream; water not running. Wood and grass abundant and good.

About four miles before reaching camp we passed the first tributary of the Trinity, which has a direction to the northeast. During the day we crossed many small ravines and gullies, containing more or less rain-water. The day has been remarkably chilly and unpleasant, the wind from the north; the night also cold.

Mules grazed, herded, &c., as usual; the day-guard over them is reduced to two men, exclusive of the herders. Observations for the time and latitude made. General direction, north 36° east; miles, $17\frac{5}{10}$.

Camp No. 50—*Saturday, April* 29, 1854.—Left camp at ten minutes after 6 a. m., and resumed our course over the beaten road over a country similar to that of yesterday. The same remarks in reference to soil, timber, grass, and water, will apply to our route to-day. We crossed a considerable stream called the West Fork, a tributary of the Trinity. About seven miles from the last camp we came upon a beautiful spring, which is covered over with rock to protect it from the sun; the water is pure and cold. Having proceeded $9\frac{1}{2}$ miles, we nooned two hours; water in holes; grass excellent. We resumed our route, and camped at ten minutes after 2 o'clock p. m. near a ravine. Our camp is in a charming locality; wood, water in ra-

vine, and grass, all excellent and in profusion. We will remain here for three days, as it is concluded to make this place one of our principal astronomical points.

Mules grazed and herded, &c., as usual. Observations made at night for time and latitude; day cloudy. General direction, north 70° east; miles, $13\frac{6}{10}$.

Same Camp—Sunday, April 30, 1854.—All hands in the command busily engaged in such work as may be requisite—repairing wagons, re-arranging the loading, shoeing and cropping the mules, &c. As usual at halting-places, the men gladly avail themselves of the opportunity for washing their clothing, &c. Our collections in mineralogy, geology, botany, and natural history, are being repacked, and placed in as small a compass as possible. Great care is taken to avoid injury to them. The collection in birds and plants is large. We have many new specimens in both, which will no doubt be interesting to men of science. Our specimens of the soils, very numerous indeed, will be found important. No opportunity has been lost, no labor spared, in collecting and increasing our contributions to these departments of science. We only regret that the limited transportation placed at our disposal prevented us from enlarging our collection to the extent we wished; the country affording inexhaustible materials. To-day we commenced an epitome of the expedition from its departure from Doña Ana to this place. Although this report was much condensed, yet it was somewhat voluminous; the great variety and importance of the matter contained in it required a considerable amount of labor to abridge, without in any material manner interfering with the facts. A profile of the country was prepared; also a summary, with a table, of the grading that may be required throughout the whole route. When finished, these documents will be sent by express to Fort Washita for transmission to Washington.

Mules herded and grazed, &c., as usual. In consequence of the unfavorable state of the weather, no observations could be made.

Same Camp—Monday, May 1, 1854.—The greater part of the night was consumed in hastening the preparation of the papers referred to in yesterday's journal. At an early hour this morning we resumed our work on these documents, and finished them about 10 a. m. The express, consisting of an American and a Mexican, started immediately for Fort Washita. This express will bring our mail to us: it is presumed we will meet it near Preston. No observations made; the weather still continues cloudy. Mules herded, grazed, &c., &c., as usual.

Same Camp—Tuesday, May 2, 1854.—One of the escort having gone to hunt last evening, had not returned during the night. The fact being reported, five men were sent in different directions to find him. During their absence the man arrived in camp; he had lost himself in the thick timber, and could not extricate himself during the darkness. In the morning, after much fatigue, he reached the camp. This will be a caution to others. During the last two days we have added some beautiful specimens of birds to our collection. Rained last night, and still continues cloudy, with occasional showers; no observations can, therefore, be made. Mules herded, grazed, &c., as usual.

Same Camp—Wednesday, May 3, 1854.—It rained heavily last night; we have had some smart showers to-day, and there is every indication of another wet night. This inauspicious weather precludes the possibility of astronomical observations. The heat is very oppressive. It is intended to remain here until the weather clears up, if it does so in any reasonable time. We, however, do not remain idle; we are getting up the business of the expedition as far as it can possibly be done. Our animals look remarkably well; rest and good grass have completely recruited them. Some of the command go out hunting; an antelope and some wild turkeys have been killed. Game of all kinds is very plenty in this locality.

It is to be observed that the streams we have passed from Fort Belknap to within five miles of this place are tributaries of the Brazos, and run in a southwesterly direction.

Same Camp—Thursday, May 4, 1854.—The weather still continues cloudy and rainy, preventing any observations from being made. We had a severe thunder-storm, with heavy rain, during the night.

Same Camp—Friday, May 5, 1854.—The weather still continues rainy and cloudy. The necessary returns and papers pertaining to the expedition are being made out, and completed as far as possible.

Same Camp—Saturday, May 6, 1854.—To-day the weather cleared. Astronomical observations for longitude and latitude made. These proving satisfactory, it is determined to resume our journey to-morrow.

During our stay we added largely to our collections of specimens.

Camp No. 51—*Sunday, May* 7, 1854.—We left last camp at fifteen minutes to 1 p. m., and resumed our route along the road we had previously been travelling. The animals showed that rest and good grass had been of service to them. They looked and worked remarkably well.

Our route to-day was through a country similar to that we had been already travelling. It is in every particular as fine an agricultural country as can be found in the world. The post-oak is in the greatest abundance, and we passed through a thick wood of it for upwards of two miles; also some hackberry and scrub-oak. Grass excellent and abundant.

We crossed several creeks and ravines, generally with water, which run in a northeasterly direction to Red river.

Encamped at twenty minutes to 5 p. m., on a ravine with running water, which was slightly brackish. Grass abundant.

Mules grazed and herded as usual. No observations made. General direction, north 80° east; miles, $11\frac{8}{10}$.

Camp No. 52—*Monday, May* 8, 1854.—Left camp at half-past 5 a. m., and resumed our course. The country still continues gently rolling and open; post-oak in abundance, with hackberry, elm, scrub-oak, &c. We are looking for the return of our express, which is a little behind its time. The distance to Fort Washita may be, however, greater than we had imagined.

Rattlesnakes are disappearing gradually since we crossed the Colorado; but, in lieu of these dangerous reptiles, we have the moccasin-snake, equally poisonous and much more treacherous.

We encamped at five minutes to 6 p. m. on Turkey creek, a tributary of the Red river, two and a half miles west of the Upper Cross Timbers. We had capital spring-water. Two barrels had been sunk by some of our predecessors, in which the water was delightfully pure and clear.

The day and night were remarkably hot; the latter cloudy and sultry to an insufferable degree. For the first time we were annoyed by the dismal croaking of the bull-frog, which made the night hideous with its never-ending and monotonous serenade.

The mules turned loose, unhobbled; grazed and herded as usual. No observations made. General direction, north 40° east; miles, $27\frac{1}{2}$.

Camp No. 53—*Tuesday, May* 9, 1854.—Our express arrived before we left camp, bringing a number of letters, but none of an official character.

We started at half-past 6 a. m., and resumed our course. At two and a half miles from camp we struck the Upper Cross Timbers, the road through which is hilly and much cut up. In many places it is sandy, and the ascents and descents very steep; yet these do not present any serious obstacle to wagons. There is here a perfect forest of large post-oak; also elm, hackberry, and other trees in abundance. In the open spaces the soil is of the best quality; grass excellent. The Cross Timbers are eight miles from west to east—that is, from the point we entered until we left them.

Reached our camp, on the east edge of the Cross Timbers, at five minutes to 11 a. m., on a well timbered ravine, in which there is a beautiful spring of water. Our encampment is delightfully situated. There was, however, one serious drawback to its enjoyment. The morning had been cloudy and threatening, raining slightly until we halted, when we had a

regular thunder-storm, the rain coming down in torrents, with hail-stones of an enormous size. It continued until near sundown, gradually abating in violence; then clearing off, the night was bright and pleasant.

The streams which we passed during our route to-day, together with the ravine on which we are camped, run into the Red river towards the north. The mules grazed and herded, &c., as usual. No observations made. General direction, north 85° east; miles, $14\frac{4}{10}$.

Camp No. 54—*Wednesday, May* 10, 1854.—The wagonmaster and a Mexican started, at half-past 5 a. m., for Fort Washita, with official and private letters for the mail; also, to select a house and encampment for the command by the time it reaches Preston, and to make some preliminary arrangements for the sale of our mules, &c., &c.

Left camp at half-past 7 a. m., and resumed our course over a rolling and open country, passing several small streams—sources of the Trinity—and encamped on the Elm fork of that river at 11 a. m.

The soil on our route to-day is of a darker color, and appears richer than any we have yet seen. The timber is not so abundant as it has been for some time past. The country is more open, with a most luxuriant growth of excellent grass.

Our camp is delightfully situated; the banks of the creek are covered with elm, post-oak, some walnut, and other trees; water and grass abundant and good.

It is a matter of some surprise that this section of country, to which nature has been so liberal of her favors, is not more settled. The soil and climate invite the farmer, assuring him a rich return. The dread of Indians is, no doubt, the principal cause; and also, perhaps, the ignorance of the advantages which are offered to the emigrant and settler, may furnish another reason. Our survey, by bringing its resources properly into notice, will remove the latter cause; the removal of the former will follow as an inevitable sequence.

Mules grazed and herded as usual, &c., &c. Observations made for longitude and latitude. General direction, north 78° east; miles, $9\frac{2}{10}$.

Camp No. 55—*Thursday, May* 11, 1854.—Left last camp at ten minutes after 7 a. m. There was a heavy dew last night, and there would be little necessity for rain if such dews were frequent. We resumed our course over a high ridge; the road was very muddy and heavy in many places, the result of the late rain.

The country is more open than it has been for the last few days; but the banks of the streams along our route are covered with an abundance of timber. The richness of the soil cannot be excelled; the quality of the grass cannot be equalled.

We crossed several small tributaries of the Trinity, and encamped at 11 a. m. at Elm fork. The bank on the west side is steep, being worn away by the action of the water; that on the east side is more sloping. We passed over it without any difficulty. The bottom is rocky and firm, being composed of limestone and gravel; the water is pure and clear—very deep in some places, with plenty of perch, bass, sunfish, &c. From appearances there must be a swift and overwhelming current after heavy rains, but it quickly subsides. We found here many curious specimens of fossil. This stream is bordered by a growth of large timber; elm and red, white, and post-oak predominate. There are some few trees of hickory, dogwood, and walnut.

As the day was warm and sultry, many of the command refreshed themselves by swimming, washing, &c. In anticipation of our speedy arrival at Preston, our razors were brought into active requisition; beards of the most patriarchal cut were trimmed down to ordinary dimensions, or totally demolished, and the cherished moustache disappeared beneath the ruthless hand of the barber. These operations caused much pain and many an expression of regret; but whether occasioned by the loss of these "facial developments" or by the bluntness of the razor, is a matter for conjecture.

About a mile from camp there is a farm-house, beautifully located. The owner, a person named Hewitt, settled here last fall. This farm appeared well stocked. Two families live here: there are six young children, who appeared sickly; indeed, two of them suffering from

ague. Many (to us) great luxuries were purchased here, such as chickens, eggs, butter, and milk. We were not able to obtain more than five bushels of corn, at $1 50 per bushel; the owner, as he stated, had bought his corn, not having time to raise any since he settled.

Our animals were grazed until sundown; then driven in and fed with corn, herded, &c., &c. No observations made; night cloudy. General direction, south 80° east; miles, 11.

Camp No. 56—*Friday, May* 12, 1854.—Left last camp at ten minutes after 6 a. m., and resumed our course. Our route was similar to that of yesterday. In respect to soil and vegetation, it was somewhat more timbered; the road was heavy, but our animals travelled capitally. It was truly pleasant to see the farms, of which there were several along our course; one particularly was on a grand scale, having a large amount of land well fenced in and thickly planted with fruit trees. All these farms appear well stocked.

About six miles from camp we reached Gainsville, which is beautifully located, and is no doubt the nucleus of a flourishing and important city. It consists of about fifteen houses; has two groceries, with their inseparable companion, a court-house, and a couple of dry-goods stores. We purchased ten bushels of corn, at $1 50 per bushel; this price is as exorbitant as that charged for the same article in New Mexico. Everything else is dear in proportion. Tobacco, (very poor,) $1; sugar, 19 cents; coffee, 24 cents; tea, $2 per pound. This scale of prices will, after a short time, find its level.

We did not see Gainsville under the most favorable circumstances, as it rained sharply while we waited for the corn to be loaded. We noticed, however, some of the celebrities of the place, among whom the "Doctor" was the most conspicuous. He sported white inexpressibles, which contrasted strangely and strongly with the surrounding black and wet soil. It would not be charitable or humane to wish *him* success, at least, in his legitimate profession. There would appear to be some ague in this locality. Building-lots can be purchased in the town for $50.

Bidding adieu to Gainsville, we pursued our course, and encamped at 11 a. m. near a stream of excellent water, a tributary of the Trinity. During our day's march we passed a number of small streams and rivulets, all the sources of this river. Our encampment is situated in a dense grove of post-oak, which completely shelters us from the wind and rain. Along the margin of the stream there is plenty of fine elm and red and white oak, of a large size. The day was cloudy and rainy until near sundown, when it cleared off.

We were informed by a person who passed through our camp, that some Waco Indians had stolen some horses from the neighboring settlements, and two of them killed the day previous; the Red river being very high at the time, prevented the rascals from crossing.

The mules were not fed with corn; they were grazed, herded, &c., as usual. No observations made; night cloudy. General direction, north 50° east; miles, $12\frac{6}{10}$.

Camp No. 57—*Saturday, May* 13, 1854.—Left last camp at ten minutes past 6 a. m., and pursued our course over a rich, well-timbered, and gently-rolling country. In our day's march we passed a number of small creeks, with running water, tributaries of the Red river. About seven miles from last camp we struck the Lower Cross Timbers, which consist of a dense growth of red, white, and post-oak, elm, and some hickory. The timber is somewhat larger than that in the Upper Cross Timbers. This place is about fifteen miles through. We encamped at half-past 11 a. m., on the banks of a heavily-timbered ravine, which contained rain-water. It is bordered with post-oak and elm of a tolerably large size. The grass is excellent, and in the utmost abundance.

Our encampment is situated at a little distance from several very fine farms. One of the most extensive belongs to a person named McCarthy. These farms, though but recently settled, present every indication of prosperity. They are well stocked, and the horses are particularly fine. We purchased twenty bushels of corn, at one dollar and twenty-five cents per bushel. The corn had not been raised here, but was bought at Preston and hauled to this place. There is in this neighborhood an extensive coal-mine; but it was too distant from camp to obtain a specimen.

Mules driven in at sundown, fed with corn, hobbled, and turned out to graze as usual. Observations made for time and latitude. General direction, ——; miles, $14\frac{4}{10}$.

Camp No. 58—*Sunday, May* 14, 1854.—There fell during the night a very heavy dew; indeed the heaviest we had yet experienced. This morning was cold and damp.

Left last camp at half-past 6 a. m., and resumed our course. Our road for some distance was over a fine rolling prairie, with settlements scattered along, beautifully located. About seven miles we entered a densely-timbered wood, the road through which was miserably bad. It appeared to have been recently covered over with water. At its eastern edge it is bounded by a rapid and deep stream, with high and miry banks, which must be nearly impassable after heavy rains. It occasions a considerable amount of labor to cross it, This stream is called the "Big Mineral," in consequence of its waters, when high, becoming brackish. Having crossed, we resumed our march over a capital country. Soil excellent; abundance of timber, (post-oak, elm, &c.,) water, and grass.

Mitchell, the express, met us at about 9 a. m., bringing some letters from Washita. He had selected the camp as directed. Reached camp, which is about six miles from Preston, at 12 noon, on the margin of a small running stream, evidently proceeding from a spring. The water is slightly brackish. We had no occasion to use it, as there was plenty of rain-water in the ravine round our camp. As on the previous day, we passed several small streams and rivulets, all tributary to the Red river.

We met a gentleman, (Mr. Massie,) an extensive land-owner, from whom we received considerable information about the navigation of the rivers, &c. He remained with us some time in camp.

Our encampment is situated at a short distance from an extensive farm. There is a large number of peach-trees planted here. Mules treated as on the previous evening, &c. No observations made. General direction, ——; miles, $14\frac{4}{10}$.

Camp No. 59—*Monday, May* 15, 1854.—Moved on to Preston, distance $5\frac{7}{10}$ miles. Spent nearly the whole day in crossing to the east side of the Red river. Preston is situated on a bluff, one hundred and fifty feet above the bed of the river, and is a small, dilapidated place, containing probably five hundred persons. Encamped near Tyson's farm.

From May 15th to May 25th, employed in discharging the men and selling the animals and wagons; then moved forward to Fort Washita, where the field-work of the expedition was closed. On the 10th of July moved forward to Fort Smith, and from thence to Washington city.

APPENDIX B.

PRELIMINARY REPORT ON THE NATURAL HISTORY.

SMITHSONIAN INSTITUTION,
Washington, October 1, 1854.

SIR: I have duly received the zoological collections made during your exploration of the country between El Paso and Fort Smith; and, in obedience to your request, herewith present a brief memorandum of their character and extent. The materials thus gathered prove to be of very high interest; as, besides a number of very rare or hitherto undescribed species, there are many the geographical distribution of which can be determined with a degree of precision hitherto unattainable. The most important of your contributions to natural science is to be found in the department of ornithology, which, as will be seen, numbers one hundred and twenty (120) species, including the collections made by Dr. Henry, United States army. The mammals are in considerable variety, as are the reptiles and fishes likewise. The precise number of the last-mentioned objects cannot now be given with exactness, as they are still in the fourteen large jars in which they were received; from which they will, however, be transferred and assorted as soon as suitable bottles can be procured. They are, of—

	Specimens.	Species.
Mammals	26	13
Birds	283	120
Reptiles (about)	33	20
Fishes (about)	30	17
Insects and other invertebrata, say	200	60
Total	572	230

Of these, probably thirty species are entirely new. I hope at the earliest possible moment to present you with a full report on these various specimens, with the necessary descriptions and illustrations. Until then, believe me,

Very respectfully, your obedient servant,

SPENCER F. BAIRD.

Captain JOHN POPE,
United States Army.

APPENDIX C.

REPORT ON THE SOILS AND MINERAL WATERS.

PHILADELPHIA, *October* 24, 1854.

DEAR SIR: I have completed the examination of the eighteen specimens of soils which you forwarded to me; and, although a more thorough examination might be made of them, and with advantage, yet the limited time would not admit of it; and perhaps the present results may sufficiently meet your designs.

The annexed Table I, presents the per-centage composition of the soils in an absolutely dry state, together with the numbers and localities by which you designated them. (See Table I.)

Of Table I, I remark, first, that the amount of lime was determined in all cases where there appeared to be about one per cent., but its presence was proved in all other cases. The deficiency in the total column is partly due to ingredients which were only tested for, but chiefly to the carbonic acid united with lime in the soil. In some of them, as in Nos. 1, 5, 6, and 17, a portion of the lime only is carbonated; the remainder being united with organic matter, except the small quantity existing as sulphate of lime.

Magnesia, manganese, chlorine, phosphoric and sulphuric acids, were severally tested for, but their quantities not determined. Their relative amounts, approximately determined, are indicated by the figures 1, 2, and 3. The alkaline test, similarly indicated, is chiefly due to lime. The organic matter is, in many cases, too high to express that portion which is generally regarded as contributive to fertility; and part of it is due to fine rootless, which were separated with difficulty, and imperfectly. It may be observed, however, that the water originally in the air-dried soil bears a proportion to the content of organic matter.

The analysis of No. 4 shows that it is not a soil, but chiefly gypsum, or plaster of paris. The following is a better expression of its composition:

Dry sulphate of lime.....	71.23	} Gypsum = 90.08 per cent.
Water of the sulphate.....	18.85	}
Carbonate of lime.....	0.46	
Silica.....	8.44	
Alumina and oxide of iron.....	0.74	
Hygroscopic moisture.....	0.45	
	100.17	

Since silica forms the frame-work of every soil, I have calculated the annexed Table II from the former, so as to compare the several ingredients with 100 parts of silex. No. 4, not being a soil, is omitted. (See Table II.)

The texture of soils is due to their content of alumina and oxide of iron, and the state of division of silex and silicates. Since the proportion of the two former varies from $3\frac{1}{2}$ to 6 in 14 out of the 17 soils, is about 11 in No. 18, and is nearly 3 in No. 14, all except one (13) have a good texture.

In the bases—lime, magnesia, and manganese—the soils are not in general deficient. The

most important (lime) is contained in all, and in some of them in large proportion. Magnesia is wanting only in two cases, while more than one-half contain manganese, which is the least important.

The soils contain only minute quantities of the acid constituents, as is usually the case. Chlorine, indicative of common salt, is only wanting in two cases. Sulphuric acid, indicating sulphate of lime, is contained in thirteen soils, and in sufficient quantity. The most important, phosphoric acid, is found in only six specimens, and in one of these its presence is doubtful. But I may remark of this acid, that exceedingly minute quantities are known to produce a fertilizing effect; and yet its detection, in such cases, lies just at the limit of our capacity of testing its presence.

Judging from the mineral composition of the soils, as above developed by analysis, I would consider them all either as good soils or capable of a high degree of improvement. Nos. 1, 2, 3, 5, and 13 are light soils, the last one of which is inferior. Nos. 6, 8, 9, 10, 11, and 14 are heavier loams, of good quality; but No. 6 appears to have but little depth, and No. 8 is rather too heavy. Nos. 12, 15, 16, 17, and 18 are similar in composition and texture, and appear to contain available organic matter; the first and last of these appear to be superior to the rest. No. 18 contains all the ingredients requisite to a good soil except the alkalies, which were not tested for.

Analysis of Waters.—The quantity of water was, in some cases, too small to make a thorough analysis of the substances dissolved; a qualitative examination of the constituents was therefore made, in order to determine the peculiar character of each water. The gallon is here taken at 60,000 grains.

No. 1. Head of Delaware creek, spring, temperature 60° Fahrenheit, March 4, 1854. This water contains 330 grains of solid matter per gallon, and it consists of a large quantity of sulphate and muriate of soda, of some sulphate of magnesia, of a small amount of sulphate of lime, and of a portion of sulphuret of sodium. The annexed Table III exhibits the approximate quantities of the several substances named above in all the waters. (See Table III.)

Nos. 1, 2, 6, and 7 are strong enough to allow of a detailed examination of their constitution, although the table sufficiently expresses their character.

I have the honor to be, your obedient servant,

JAS. C. BOOTH.

Captain JOHN POPE,
U. S. Top. Engs., Washington, D. C.

TABLE I.

Number.	Description of locality.	Silica.	Alumina and oxide of iron.	Manganese.	Lime.	Magnesia.	Organic matter.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Total.	Alkalinity.	Water originally in air-dried soil.
1	Bottom land, Delaware Springs	87.08	3.53	1	6.07	1	1.56	....	2	1	98.24	1	3.50
2	Valley bottom, junction of Pecos river and Delaware creek	83.71	3 88	2	5.65	1	2.35	....	2	1	95.59	2	2.02
3	East bank of Pecos, mouth of Delaware creek—high ground	89.13	4.04	2	2.70	1	2.17	....	.....	1	98.05	1	2.42
4	First camp Delaware creek—high ground	8.44	0.74	...	29.59	2	.....	....	41.90	...	99.97	1	19.30
5	High land junction of Delaware creek and Pecos	79.96	3.58	2	8.31	1	3.51	....	.....	1	95.36	1	2
6	Eighty miles east of Pecos, on Llano Estacado	81.66	3.12	....	7.87	1	3.21	....	1	1	95.86	....	2.54
7	Llano Estacado, at camp, night of March 27	74.16	4.64	3	8.09	3	4.18	....	1	1	91.07	1	3.93
8	Valley of Colorado, April 15	90.05	3.90	....	2.22	1	1.79	1	.....	1	97.96	1	3.60
9	Rolling country, at camp, night of April 27	91.98	5.69	1	2	1	1.83	1	2	1	99.50	....	2.96
10	At camp, at noon, April 26	91.68	5.71	2	2	....	2.19	1	1	....	99.58	....	2.28
11	From a bend in Elm creek, en route, April 20	92.32	5.07	1	2	1	2.07	....	2	1	99.46	....	3.38
12	Cross Timbers, en route, forenoon of May 9	91.94	3.40	....	2	1	3.70	1	1	....	99.04	....	7.02
13	Cross Timbers, en route, May 9	98.03	1.16	....	2	1	0.87	1?	.....	1	100.06	1	1.52
14	Camp in night of May 7	95.63	2.62	....	2	....	1.19	....	2	2	99.44	1	2.26
15	.....	91.62	4.23	....	2	1	3.19	....	2	1	99.04	1	5.86
16	Rolling country, en route, May 13	92.64	4.76	....	2	1	1.96	....	1	1	99.36	1	5.10
17	At camp, on night of May 11	89.85	3.20	....	1.25	1	5.19	....	2	1	99.49	2	7.94
18	En route, May 10—rolling country	81.14	9.43	2	2	1	6.75	1	1	1	97.32	1	11.08

TABLE II.

Number.	Results of analysis compared with 100 parts of silica.											Description.	
	Silica.	Alumina and oxide of iron.	Manganese.	Lime.	Magnesia.	Organic matter.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Alkalinity.	Water originally in air-dried soil.	Color.	Texture.
1	100	4.05	1	6.97	1	1.79	.....	2	1	1	3.50	Light colored....	Fine sandy.
2	100	4.64	2	6.75	1	2.81	.....	2	1	2	2.02	Light yellowish..	Fine sandy.
3	100	4.53	2	3.01	1	2.44	.....	.....	1	1	2.42	Reddish	Fine sandy.
5	100	4.47	2	10.40	1	4.39	.....	.....	1	1	2	Light colored....	Fine sandy.
6	100	3.82	.....	9.63	1	3.93	.....	1	1	.....	2.54	Reddish	Tenacious loam; at one foot below surface the specimen consists of silicious stones.
7	100	6.26	3	10.90	2	5.64	.....	1	1	1	3.98	Grayish.....	Fine sandy, full of lumps of limestone and gravel.
8	100	4.34	.....	2.47	1	1.98	1	.....	1	1	3.60	Red..	Very tenacious, clayey.
9	100	6.19	1	2	1	1.99	1	2	1	.....	2.96	Reddish.....	Slightly tenacious, clay, and fine sand.
10	100	6.23	2	2	.....	2.39	1	1	.....	.....	2.28	Light reddish....	Loam, clay, and fine sand.
11	100	5.49	1	2	1	2.24	.....	2	1	.....	3.38	Light reddish...	Loamy, clay, and fine sand.
12	100	3.70	.....	2	1	4.03	1	1	.....	.....	7.02	Dark.....	Tenacious, clay and very fine sand.
13	100	1.18	.....	2	1	0.89	1?	.....	1	1	1.52	Gray	Fine and a little coarse sand.
14	100	2.74	.....	2	.....	1.24	.....	2	2	1	2.26	Reddish	Somewhat tenacious, clay, coarse and fine sand.
15	100	4.62	.....	2	1	3.48	.....	2	1	1	5.86	Dark.....	Tenacious, clay and very fine sand.
16	100	5.14	.....	2	1	2.12	.....	1	1	1	5.10	..do.....	Tenacious, clay and very fine sand.
17	100	3.56	.....	1.39	1	5.78	.....	2	1	2	7.94	..do.....	Tenacious, clay and very fine sand.
18	100	10.94	2	2	1	7.82	1	1	1	1	11.08	..do.....	Tenacious, clay and very fine sand.

TABLE III.—MINERAL WATERS.

Number.	Locality of water.	Chloride of sodium.	Sulphide of sodium.	Sulphide of soda.	Carbonate of soda and lime.	Sulphate of lime.	Sulphate of magnesia.	Silica, alumina, and oxide of iron.	Total solid matter per gallon.	Alkalinity of unevaporated water.	Remarks.
1	Head Delaware creek, spring, temp. 60° Fahr., March 4, 1854.	3	2	1	.....	.....	1	1	320	Alk.	The waters are alkaline previous to evaporation, except No. 5, and this alkalinity is chiefly due to sulphide of sodium; partly also to the alkaline carbonate. The carbonate is chiefly that of soda; only a small amount being carbonate of lime. The approximate amounts—little, much, and very much—are expressed by the figures 1, 2, and 3. It is interesting to observe that the sulphuretted salt waters of the springs Nos. 1, 2, and 3, as they pass down Delaware creek, lose their sulphuretted character in No. 4; their sulphur having been oxidized into sulphuric acid, so as to form sulphate of soda and lime. It appears, however, that in the Pecos the sulphuric acid has almost entirely disappeared.
2	Spring head Delaware creek.....	3	3	.....	1	.....	.....	1	315	Alk.	
3	Spring head Delaware creek, temp. 61° Fahr., March 4, 1854.	3	2	.....	1	.....	1	1	60	Alk.	
4	Delaware creek, thirty miles below springs, ten miles above mouth.	3	.....	2	.....	1	1	1	187	Alk.	
5	Pecos river.....	3	.....	.....	.....	.....	.....	1	166½	Neutrl.*	
6	Mustang springs, or "La laguna"..	3	3	2	1	1	1	1	230½	Alk.	
7	Stream, Camp No. 40.....	3	3	1	.....	1	1	1	392	Alk.	
8	Sulphur springs, Colorado.....	3	2	.....	1	.....	1	1	51	Alk.	

* Contains much chloride of calcium.

APPENDIX D.

NOTE UPON THE GEOLOGICAL REPORT.

The geological collection made by Captain Pope has been placed in the hands of Mr. Wm. P. Blake for description and a report in detail, which is not now completed, but will appear in a supplementary volume. The preliminary report by Mr. Jules Marcou, upon the collection, published as Chapter XIII in the preliminary report in octavo, is therefore omitted in this place. The reference on page 80 of the quarto edition of the Report of the Secretary of War, under the head of "Building-stone," refers to Chapter XIII of the preliminary report in octavo.

APPENDIX E.

TABLE OF CAMPING PLACES ALONG THE DIRECT LINE OF SURVEY.

Date.	Camp.	Distance from camp to camp.	Total distance from El Paso.	Remarks.
		Miles.	*Miles.*	
Feb. 21	Camp No. 1, Hueco Tanks	.....	24.3	Water, in natural tanks; wood and grass.
22	Camp No. 2, in pass of the Cerro Alto	5.4	29.7	No water; brush for wood; good grass.
23	Camp No. 3, Sierra de los Alamos	23.2	52.9	Spring water; grass good; cactus for wood, not very abundant.
24	Camp No. 4, Los Cornudos	8.2	61.1	Water in natural rock tanks; wood, small trees; grass.
25	Camp No. 5, on the open plain	11	72.1	No water; cactus for wood, in abundance; fine grass.
26	Camp No. 6, Ojo del Cuerbo	13.1	85.2	Water in abundance; fine springs, (sulphurous;) grass poor; small brush for wood.
27	Camp No. 7, in pass of Guadalupe mountains.	11.6	96.8	No water; cactus for wood, in great quantities; fine grama-grass.
28	Camp No. 8, near head of cañon in Guadalupe Pass.	10.7	107.5	Fine spring water; no wood; grass, but not very good or abundant.
Mar. 1	Camp No. 9, pinery on the east slope of Guadalupe mountains.	4.7	112.2	Water, wood, and grass, in the greatest abundance, (fine springs;) pine groves; grama-grass.
2	Camp No. 10, near Independence springs.	5.9	118.1	Three fine and large springs; thickets of scrub-oak and hickory; good grass.
3	Camp No. 11, head springs of Delaware creek.	14.5	132.6	Several fine mineral and fresh-water springs; grass good; no wood near.
6	Camp No. 12, on Delaware creek	11.3	143.9	Water, wood, and grass; water sulphurous; dwarf cedar for wood; grass not very good.
7	Camp No. 13, on Delaware creek	13	156.9	Water of Delaware creek; plenty of roots for wood; good grass.
	Camp No. 14, on Pecos river, at mouth of Delaware creek.	5.7	162.6	Water, wood, and grass abundant; roots for wood.
April 8	Camp No. 15, on the Llano Estacado	25	187.6	No water; grass good, and roots for wood.
9	Camp No. 16 ..... do	36.5	224.1	No water; grass not very good; roots for wood.
10	Camp No. 17 ..... do	29	253.1	No water; good grama-grass; roots for wood.
11	Camp No. 18, Sulphur springs of the Colorado.	34.2	287.3	Water plenty and good; grass good; roots for wood.

TABLE OF CAMPING PLACES—Continued.

Date.	Camp.	Distance from camp to camp.	Total distance from El Paso.	Remarks.
		Miles.	*Miles.*	
April 12	Camp No. 19, on the open plain.....	11.9	299.2	No water; good grass, and mezquite groves for wood.
13	Camp No. 20 .....do.....	14	313.2	No water near; grass good; mezquite groves.
14	Camp No. 21, on the Colorado.....	18.1	331.3	Water, wood, and grass.
15	Camp No. 22, on a creek with pools of water.	11.5	342.8	Water, wood, and grass; mezquite for wood.
16	Camp No. 23, on dry tributary of the Brazos.	13.1	355.9	Mezquite for wood; good grass: no water, but water in abundance ten miles west, and five miles east.
	Camp No. 24, on a creek with pools of bitter water.	15.2	371.1	Groves of heavy mezquite for wood; grass tolerably good. Passed plenty of good water during the day at convenient distances.
18	Camp No. 25, on dry tributary of Clear fork of Brazos.	16.8	387.9	No water; abundance of mezquite; good grass.
19	Camp No. 26, on large creek with pools of water.	16.9	404.8	Abundance of water, wood, and grass.
20	Camp No. 27, on tributary of the Brazos.	16.2	421	Water, wood, and grass, (good.)
21	Camp No. 28, on Clear fork of the Brazos.	12.2	433.2	Water, grass, and wood, in abundance.
22	Camp No. 29.....do.....	3.2	436.4	Do do do.
24	Camp No. 30.....do.....	15.5	451.9	Do do.
25	Camp No. 31, on a small creek.....	16.8	468.7	Do do.
26	Camp No. 32, on west bank of Brazos river.	15.6	484.3	Do do.
27	Camp No. 33, on a creek of running water.	10.1	494.4	Do do.
28	Camp No. 34, on a creek with pools of water.	16.2	510.6	Do do.
29	Camp No. 35, near two creeks, with plenty of water.	12.6	523.2	An abundance of wood; water good; grass very good.
May 7	Camp No. 36, on a creek with a rocky bed.	11	534.2	Water, wood, and grass, all good.
8	Camp No. 37, on a creek with standing water.	26.1	560.3	Plenty of water, wood, and grass.
9	Camp No. 38, on east edge of Upper Cross Timbers.	13.6	573.9	Water in springs to the north of the road, and in a ravine; wood plenty; grass good.
10	Camp No. 39, on Elm fork of the Trinity river.	8.8	582.7	Water, wood, and grass, (good.)
11	Camp No. 40, on Clear fork of the Trinity river.	10.5	593.2	Water, wood, and grass, good and abundant.
12	Camp No. 41, on a creek of running water.	11.8	605	Do do.
13	Camp No. 42, near eastern edge of Lower Cross Timbers.	13.6	618.6	Water, wood, and grass, (good.)
14	Camp No. 43, on a creek flowing into Red river.	13.5	632.1	Do do.
15	Preston, on Red river.	7.3	639.4	

APPENDIX F.

Meteorological Observations on Survey for route for Pacific Railroad, from Doña Ana, New Mexico, to Preston, Texas, under the command of Brevet Captain John Pope, Corps of Topographical Engineers.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air. A. M. Sunrise.	A. M. Noon.	P. M. Two o'clock.	P. M. Sundown.	P. M. Nine o'clock.	Temperature of the earth three feet beneath the surface.	Temperature of the water at camping places.	Remarks in reference to springs and water at camping places.	Winds. Coarse.	Winds. Nature of— Morning.	Winds. Nature of— Afternoon.	Remarks concerning the weather and the state of vegetation.
1854,		*Miles.*	°	°	°	°	°	°	°					
Feb. 22	Hueco Tanks			57½	67	50	42	48	43 at the Tanks.	Water found in natural tanks in the rocks within caves.	E.	High wind	High wind	Weather clear and fine; vegetation backward.
23	Plain	4.2	29	58	64	55½	51	48	No water	No water	SW.	High wind	Breeze	Day clear; evening cloudy.
24	Cotton Wood Springs	20.8	42	66	62	48½	45	48	49	A spring with a scanty supply	SW.	Breeze	High wind	Morning clear; afternoon slight rain.
25	Thorn's Wells (Los Cornudos.)	9	34	51	56	46	31	47½	50⅛	Natural cisterns exposed to the sky.	NW.	Breeze	Breeze	Morning cloudy; evening clear.
26	Plain	12	11½	59	70	56	35	47½	No water	No water	SW.	Breeze	Calm	Day clear; evening clear.
27	Ojo del Cuerbo (Crow Springs.)	17.1	22	69	78	55	38	51	48	Springs and a lake, both brackish; soil moist.	SW.	Calm	Breeze	Fine weather; perfectly clear.
28	Plain	12.4	28	78	78	60	54	51	No water	No water	W.	Calm	Calm	Morning clear; evening cloudy.
Mar. 1	Guadulupe Pass	11.8	51	59	55½	53	40	50⅛	45⅛	Spring at foot of the "High Peak".	W.	Stormy	Stormy	Morning cloudy; day clear.
2	Pinery	4.1	34	55	56	44	25	49	58⅛	Spring at the foot of a mountain	W.	High wind	Breeze	Day clear; vegetation backward.
3	Independence Springs	6.3	38	68	72	48	32	50	64	Two springs about 40 yards apart. Water clear and good.	W.	High wind	High wind	Day clear; vegetation improving as we descend from high table-land.
4	Delaware Spring	16.1	20	60	66	51	37	51	Spring No. 1, 60°.	Spring of sulphur No. 1, (see samples.)	E.	Calm	Breeze	Day clear.
5	do	0	30		72	64	49	51	Spring No. 3, 64°.	Spring of sulphur No. 3, (see samples.)	E.	Breeze	Calm	Cloudy all day.
6	do	0	45½	70	75½	68	53½	51	Spring No. 2, 61°.	Spring of sulphur No. 2, (see samples.)	SW.	Calm	Breeze	Cloudy; rain in the evening; thunder-storm at night.
									65	Spring of fresh water, (see samples.)				
7	Delaware Creek	12.2	40	80⅛	79	72	48	57	58	Clear stream, 6 feet wide	SW.	Breeze	Breeze	Day clear; night cloudy.
8	do	13.9	38	77	77	60	46	49	58	do do	W.	Breeze	High wind	Morning cloudy; afternoon clear.
9	Falls of the Rio Pecos, mouth of Delaware Creek.	6	40	65	69	53½	42	49⅛	57	Muddy and rapid stream, about 80 feet wide. Delaware creek has an average width of about 6 feet at and above its junction with the Pecos; water clear and transparent, but very brackish. The water of the Pecos is muddy and brackish.	N.	High wind	High wind	Day cloudy; evening cloudy.
10	do	0	28	67	71	60	42	51	57		W.	Calm	Breeze	Day clear.
11	do	0	24	73	79	67	57½	51	57		NW.	Breeze	Breeze	Day clear.
12	do	0	36	82	76½	68½	65	51	57		W.	Breeze	Strong breeze	Day cloudy; threatening rain.
13	do	0	46	71	70½	64½	54	51	57		W.	Breeze	Breeze	Day cloudy.
14	do	0	43	82	81½	58	49	52	60		E.	Calm	Calm	Day cloudy; evening floating clouds.
15	do	0	37½	63	88	73	58	53	63		SW.	Breeze	Breeze	Day and evening clear.
16	do	0	42	89	94	78	52½	54	65		W.	Calm	Breeze	Morning floating clouds; evening clear.
17	do	0	41	91	98	81	73	54	65		W.	Breeze	Strong breeze	Morning floating clouds; evening clear.
18	do	0	45	82	82	68	62	55½	63		SW.	Breeze	Breeze	Morning floating clouds; evening cloudy.
19	East side of Rio Pecos	12.4	53	55	54	54⅛	53	66	60	Water brackish and muddy	E.	Breeze	Breeze	Morning slight rain; evening appearance as if clearing up.
20	do	19.6	50	80	89	67	54	66	63	Water brackish	SE.	Calm	Breeze	Morning cloudy and misty; evening clear.
21	do	17.2	41	84	81	67	58	66	63	do	W.	Breeze	Breeze	Morning clear; afternoon cloudy.
22	do	20.4	52	82	82	74	68	63	64	do	W.	Calm	Calm	Day cloudy; a few drops of rain at night.
23	do	7.2	58	88	82	73	68½	68	66	do	SW.	Calm	Breeze	Floating clouds; evening dark clouds.
24	do	19.8	51	88	93	72	72	Rocks	No water		W.	Calm	Breeze	Clear day; rain in the night with lightning.
25	Llano Estacado	16.4	49	73	76	46	40	63	70	Ponds of rain water	W.	Breeze	High wind	Clear day.
26	Sand Hills	12.6	44	50½	56	50	42	63	No water		E.	Breeze	Calm	Cloudy all day.

27	Llano Estacado	18.9	34	74	76	66	56	Rocky underneath the soil.	No water	There are dry beds of ponds in this vicinity; no doubt in wet weather they fill with water.	SE.	Breeze	Breeze	Clear day; heavy dew in the morning for the first time on our journey; the plain covered with flowers.
28	Llano Estacado	28.8	47	80	82	64	60	62	No water	Dry beds of ponds, but no water at present.	SE.	Breeze	Strong breeze	Dew in the morning; atmosphere more humid. A heavy mass of clouds driving from SE. clouded the sky in the morning for a few hours; the day afterwards clear; grass greener to-day.
29	Mustang Springs	13	54	84	88	70½	58	60	69	Lakes of water somewhat saline	S.	Breeze	Breeze	Fog in the morning; day clear.
30	Llano Estacado	10.8	60	88	88	76	64	62	No water	No water	W.	Breeze	High wind	Fog in the morning; day clear, the wind changing gradually from SE. to W.
31	Big Springs of the Colorado.	10.8	48	58½	59	50	41	Rocky underneath the soil.	62	A fine spring issuing in a deep pool 20 yards in diameter, situated amid surrounding rocks; water good; runs off in a stream about as thick as a man; a beautiful camping place.	N.	High wind	High wind	A high wind all night, the wind shifting gradually north about 9 a. m.; floating clouds; no dew.
Apr. 1	Llano Estacado	10.6	29	59	63	51½	42	62	No water	No water	SE.	Breeze	Strong breeze	The wind shifting from SE. to S., and back again to SE., during the day; light clouds floating all day.
2	Sulphur Springs of the Colorado.	16	31	67	74	69	54	62½	59	A number of slender springs issuing from the side of a ravine; the water of one spring impregnated slightly with sulphur; the water of the remainder of good quality, holding a small quantity of lime in solution.	SE.	Strong breeze	Strong breeze	Day clear; no dew in the morning.
3	do	0	44	79	84	70	59	62½	59		S.	High wind	High wind	Day clear; no dew this morning, the wind blowing with a strong current SE. all night.
4	do	0	54	78	76	61½	44	62½	59		N.	High wind	Strong breeze	Calm during the night; wind rose in the morning; clear morning; afternoon white clouds; evening clear and calm.
5	do	0	32	84	88	66	46½	62½	59		SW.	Calm	Breeze	Heavy dew in the morning; the day clear; beautiful sunset.
6	do	0	34	92	92½	70	58	62½	59		SW.	Gentle breeze	Gentle breeze	Day clear.
7	do	0	45	91	94	73	69	62½	59		S.	Strong breeze	Strong breeze	In the morning occasional dark clouds driving over the sky; the rest of the day more cloudy. In the evening a beautiful sunset, the remainder of the sky being overcast.
8	do	0	56	80	82	66	50	62½	59		W.	Strong breeze	Strong breeze	Night high wind. In the morning cloudy towards sunrise; day, thin white clouds, occasionally; wind changed to the north towards evening.
9	do	0	28	62½	68	56	42	62½	59		N.	Strong breeze	Strong breeze	Morning clear; wind changeable. In the evening light filmy clouds. The cold nights seem to retard vegetation.
10	do	0	41	68	74	60	49½	62½	59		E.	Strong breeze	Strong breeze	Morning cloudy; afternoon clear; the wind changed around to the south towards evening.
11	do	0	38½	87	88	60	47½	62½	59		W.	Gentle breeze	Gentle breeze	Dew in the morning; the day clear; evening calm.
12	do	0	36	89½	88	78½	64	62½	59		SW.	Gentle breeze	High wind	Slight dew: entire day clear; the wind changed to the south towards evening.
13	Plain	11.4	49	79	81	68	58	66	No water	No water	W.	High wind	High wind	Morning clear; aftern'n occasional clouds.
14	do	15.1	44	70	69	58	47	66	No water	No water	NW.	High wind	High wind	Day unclouded.
15	Rio Colorado	18.2	32	69½	80	60	47	64		A stream about 3 feet wide and 6 inches deep; water red color and brackish.	N.	Breeze	Strong breeze	Dew in the morning; sky clear; afternoon occasional clouds, and a few drops of rain.
16	On a ravine	12.1	40	80	79	62	53	66		An affluent of the Colorado; water running in small stream and brackish.	NW.	Breeze	Calm	The wind very changeable in its course; no dew in the morning; day unclouded; grass green, and 3 or 4 inches high.
17	On divide of the Colorado and Brazos rivers.	16.2	43	82	87	75	64	65	No water	We passed a stream of good water at noon.	S.	Strong breeze	Strong breeze	Day clear.
18	Camp 39	16	53	87	86	76	66	65	Small pools	Small pools of water somewhat stagnant. Passed during the day ravines having pools of water very saline.	S.	Calm	Gentle breeze	The morning sultry and hazy; the afternoon filmy white clouds passing over the sky; night cloudy.
19	Camp 40, on the plain	17.6	62	82½	75	70	70	66	No water	No water	SE.	Breeze	Breeze	Morning cloudy, with rain towards the west; afternoon cloudy, with a few drops of rain; at night a heavy cloud, with lightning towards the west.
20	Camp 41, on a ravine with stagnant water.	18.1	68	90½	96	73	69	68	No water	Pools of stagnant water slightly brackish.	SW.	Breeze	Breeze	Morning cloudy; afternoon occasional white clouds.
21	Camp 42, on Elm creek.	17.4	66	98	94	83	74	69		A ravine with pools of stagnant water slightly brackish.	SW.	Breeze	Breeze	Morning clear; afternoon occasional cl ouds.

METEOROLOGICAL OBSERVATIONS—Continued.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air. A.M. Sunrise.	A.M. Noon.	P.M. Two o'clock.	P.M. Sundown.	P.M. Nine o'clock.	Temperature of the earth three feet beneath the surface.	Temperature of the water at camping places.	Remarks in reference to springs and water at camping places.	Winds. Course.	Winds. Nature of— Morning.	Winds. Nature of— Afternoon.	Remarks concerning the weather, and the state of vegetation.
1854.		*Miles.*	°	°	°	°	°	°	°					
Ap'l 22	Camp 43, Clear Fork of Brazos, running stream.	12.8	62	80	79	74	71	72	73	A stream of good water, about 20 feet wide and a few inches deep.	SE.	Breeze	High wind.....	Early in the morning clear; from 7 to 12 o'clock cloudy and threatening rain; afternoon cloudy; at night a high wind, with lightning towards the southeast.
23	Camp 44, same stream..	6.6	57	86	86	72	69	72	73	Same stream.....	S.	Breeze.....	Breeze	A storm last night, with thunder and lightning, and some rain; morning clear; afternoon occasional clouds.
24	Camp 44.....	.....	58	80	86	68	55	72	73	Same stream.....	SW.	Gentle breeze..	Strong breeze..	Cloudy last night, with a heavy storm, accompanied with thunder, lightning, and rain; day clear.
25	Camp 45, on Elm creek and Clear Fork of the Brazos.	.....	50	88	90	72	56	68	73	Same stream.....	SW	Gentle breeze..	Strong breeze..	Day clear; earth moist; appearances of recent rains.
26	Camp 46, on plain.....	18.7	63	90	97	69	62	68	No water...	No water.....	W.	Strong breeze..	Gentle breeze..	Day clear; grass from six to eight inches high.
27	Camp 47, a mile west of the Brazos river.	16.4	55	66	73	59	57	72	Rainwater in pools at camp.	Rainwater in pools.....	NE.	Strong breeze..	Strong breeze..	High wind last night, with clouds and lightning towards the north; wind in the north in the forenoon, and gradually changing round to the east by evening; morning clear; afterwards occasional clouds.
28	Camp 48, running stream	10.9	44	65	69	54	48	68	68	A running stream of good water, about 3 feet wide.	NE.	Strong breeze..	Strong breeze..	Morning clear; afternoon occasional clouds.
29	Camp 49, on a ravine..	17.5	38	68	70	60	54	69	.....	Pools of water.....	SE.	Gentle breeze..	Gentle breeze..	Heavy dew in the morning; morning clear; occasional thin white clouds in afternoon; grass very fine, six to eight inches high.
30	Camp 50, on a ravine..	13.6	45	75	76	66½	62	69	.....	Pools of water in a small ravine...	SE.	Strong breeze..	Strong breeze..	Occasional thin white clouds; grass very fine, from six to eight inches high.
May 1	.....do.....	0	58	79	79	71	68	69	.....	.....	SE.	High wind.....	Strong breeze..	Occasional clouds all day; evening cloudy; a few drops of rain.
2	.....do.....	0	62	75	78	71	67	69	.....	.....		Gentle breeze..	Gentle breeze..	Day cloudy; a few drops of rain in the afternoon.
3	.....do.....	0	64	80½	81	68	67	69	.....	.....	SE.	Gentle breeze..	Gentle breeze..	The entire day cloudy, with occasional showers of rain; a fall of rain last night.
4	.....do.....	0	63	78	78	68	64	69	.....	.....	NE.	Gentle breeze..	Strong breeze..	A heavy thunder shower last night; the morning cloudy; afternoon occasional showers.
5	.....do.....	0	62	65	68	62	61½	69	.....	.....	NE.	Gentle breeze..	Gentle breeze..	Morning cloudy, with showers of rain; afternoon cloudy and misty.
6	.....do.....	0	62	75	78	74	66	69	.....	.....	SW.	Strong breeze..	Strong breeze..	A shower of rain early in the forenoon; the remainder of the day occasional white clouds; evening clear.
	.....do.....	0	60	90	89	78	72	69	.....	.....	S.	Strong breeze..	Strong breeze..	Clear day; the wind changeable in the morning, hovering between east and south.
8	Camp 51, on a ravine..	11.8	68	90	94	75	72	70½	.....	Pools of rain-water in a ravine....	S.	Strong breeze..	Gentle breeze..	Morning clear overhead, but a cloud, with lightning, to the south; afternoon clear; light clouds in the evening.
9	Camp 52, Buffalo Springs	27.5	70	71	68	66	65	71½	66	A number of springs of good water issuing from the side of a ravine in a very slender stream.	S.	Strong breeze..	Strong breeze..	Morning cloudy, with showers of rain, with hail and lightning in the afternoon.

10	Camp 53	14.4	58	76	75	64	56	68	67	A spring of good water found by digging a few feet in a marshy spot.	NE.	Strong breeze..	Strong breeze..	Clear day; trees everywhere full of foliage.
11	Camp 54	9.2	50	81	85	70	68	67½	9	A small stream of running water ..	SE.	Gentle breeze..	Gentle breeze..	Occasional clouds all day; a heavy dew in the morning.
12	Camp 55, Dry Fork of Trinity.	11	70	72	77	73	72	70	70	A stream of clear water about 20 feet wide. The bed is said to become dry at certain seasons.	S.	High wind.....	High wind.....	Last night cloudy; forenoon cloudy, with a shower of rain.
13	Camp 56, on a ravine..	12.6	63	84	83	64	58	69	70½	A ravine, with a slender stream of water.	W.	Gentle breeze..	Strong breeze..	Early in the morning cloudy; forenoon clear; afternoon same; clear night.
14	Camp 57, near a spring.	14.4	52	76	80	67	64	68	74	A ravine, with a slender stream of good water.	E.	Gentle breeze..	Gentle breeze..	Heavy dew last night; forenoon clear; wind somewhat variable; fluctuating between east and south in the forenoon.
15	Camp 58, 6 miles west of Preston.	14.4	58	88	84	78	76	69	74	A ravine, with a slender stream of good water.	S.	Gentle breeze..	Gentle breeze..	Heavy dew last night; morning clear; afternoon cloudy, with a few drops of rain.
16	Camp 59, east side of Red river.	0	74	80	81	67	63	.....	.....	.....	S.	Strong breeze..	High wind.....	Early in the morning cloudy; the remainder of the forenoon clear; afternoon clear; the wind gradually changed round to the NW. towards evening.
17	..... do	0	53	76	79½	69	62	.....	.....	.....	W.	Gentle breeze..	Gentle breeze..	Slight dew in the morning: forenoon clear; afternoon occasional clouds.
18	..... do	0	52	84	85	72	69	.....	.....	.....	W.	Gentle breeze..	Gentle breeze..	Heavy dew in the morning; forenoon clear; afternoon clear.
19	..... do	0	64	84	84	74	70	.....	.....	.....	S.	Gentle breeze..	Gentle breeze..	Slight dew; forenoon clear; afternoon occasional white clouds; evening clear.
20	..... do	0	62	86	74	65	64	.....	.....	.....	S.	Strong breeze..	Strong breeze..	Forenoon occasional heavy clouds; heavy rain in the afternoon.
21	..... do	0	62	70	72½	68	65	.....	.....	.....	NE.	Calm	Gentle breeze..	Cloudy day.
22	..... do	0	68	80	70	69	69	.....	.....	.....	NE.	Gentle breeze..	Gentle breeze..	Morning occasional clouds; afternoon heavy showers of rain.
23	..... do	0	68	77	80	73	70	.....	.....	.....	SE.	Gentle breeze..	Gentle breeze..	Rainy last night; showers of rain in the forenoon; afternoon sunshine alternating with heavy showers of rain; evening clear.
24	..... do	0	65	82	84		66	.....	.....	.....	SW.	Gentle breeze..	Gentle breeze..	Morning clear; afternoon occasional heavy clouds, and thunder in the distance. Evening slight rain.

APPENDIX G.

Table of Latitudes, Longitudes, and Magnetic Declinations.

Date.	Station.	Latitudes.			Longitudes.			Azimuths.				Observers.
		Stars observed.	Results.	Latitudes adopted.	Lunar distances.	Results.	Longitudes adopted.	Stars observed.	True bearing from north.	Mag. bearing from north.	Variations of compass.	
			° ′ ″	° ′ ″		h. m. s.	h. m. s.		° ′ ″	° ′ ″	° ′ ″	
	Doña Ana, principal station			32 22 00			7 07 00.7					Boundary Com.
	El Paso, principal station			31 44 15.7			7 05 39.4					Do.
Febr'y 21	Hueco Tanks			31 56 37.5								Pope, Top. Eng.
22	Hueco Pass	Sirius Polaris	32 02 13 32 00 56	32 01 34.5								Do.
23	Alamos	Sun		32 03 53								Do.
24	Cornudos	Sun, *a* Ursæ Majoris.	32 08 47 32 07 06	32 07 56.5								Do.
26	Ojo del Cuerbo	Sirius Polaris		31 57 28								Do.
28	South point, Guadalupe Mt.			31 51 04								Johnston, Top. Engineers.
March 1	Pinery, east side Guadalupe Mt.	Sirius Polaris	31 57 57 31 56 28	31 57 12.5								Pope, Top. Eng.
3 and 4	Head Delaware creek, principal astronomical station.	Sirius Polaris		31 54 39	Aldebaran 12. Spica Virginis 12.		6 58 04.7*					Do.
8 to 19	Pecos river, mouth Delaware creek, principal astronomical station.	Sirius Polaris		31 56 49	Mars 13. Spica Virginis 24.		6 55 28.7*					Do.
24	Emigrant crossing of Pecos	Sun		31 20 54								Do.
24	White sand hills, west side	Sirius Polaris		31 39 43.7								Do.
26	White sand hills, east side	Sun		31 42 51.5			6 50 40					Do.
29	Mustang Springs	Spica Virginis Polaris	32 01 09 32 00 05	32 00 37			6 47 17.2					Do.
31	Big Springs of Colorado	Spica Virginis Polaris	32 05 36 32 04 29	32 05 02.5			6 45 35					Do.
April 3 to 12	Sulphur Springs of Colorado, principal astronomical station.	Spica Virginis Polaris		32 23 59	Sun 48, Saturn 24. Spica Virginis 48.		6 47 22*					Do.
16	Colorado river	Spica Virginis Polaris	32 35 44.2 32 34 51.5	32 35 18			6 44 21					Do.
17	Tributary of Brazos river	Polaris Spica Virginis	32 40 27.8 32 42 49.8	32 41 39								Do.
20	Tributary of Brazos river	Polaris Spica Virginis	32 53 45.1 32 54 45.8	32 54 15				Polaris Spica Virginis	1 20 00 W. 141 10 50 E.	11 50 00 W. 130 40 00 E.	E.10 30 25	Do.
24	Clear Fork of Brazos	Polaris Spica Virginis	32 59 24.3 33 00 49.2	33 00 07			6 36 58.5	Polaris Spica Virginis	1 01 00 W. 150 55 40 E.	12 30 00 W. 140 00 00 E.	E.11 12 20	Do.
26	Brazos river	*a* Ursæ Majoris. Spica Virginis										Johnston, Top. Engineers.
28	West Fork of Trinity	Polaris Spica Virginis	33 28 06.9 33 30 07.5	33 29 07			6 35 27.5	Polaris Spica Virginis	1 00 20 W. 142 43 02 E.	11 20 00 W. 130 30 00 E.	E.10 16 51	Pope, Top. Eng.
April 29 to May 7.	Waters of Trinity, principal astronomical station	Polaris Spica Virginis	35 31 35 33 32 48	33 31 59	Sun 24. Spica Virginis 24.	6 34 46.5 6 34 36.5	6 34 41.5	Polaris Spica Virginis	0 46 40 E. 141 19 12 E.	9 50 00 W. 131 00 00 E.	E.10 27 56	Do.
May 10	Elm Fork of Trinity, principal astronomical station.	Polaris Regulus	33 41 42 33 41 40	33 41 41	Pollux 24	6 29 31	6 29 31	Polaris	0 14 00 W.	10 50 00 W.	E.10 36 00	Do.
13	Four miles east of Lower Cross Timbers.	Polaris Spica Virginis										Do.
22	Preston	Polaris* Spica Virginis		33 48 25			6 25 28.3*					Do.
June 22	Fort Washita, C. N	Polaris* Spica Virginis		34 09 18			6 25 48.5*					Do.

The points marked thus (*) have been only approximately determined. The final results are not yet computed.

APPENDIX H.

Altitudes of Stations above the sea-level.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
1	.....	3830	Molino, on the Rio Grande, near El Paso.
2	2870	3860. 4	
3	2334. 3	3897. 4	
4	1287. 6	3904. 4	
5	382. 6	3911. 8	
6	2793. 5	3927. 2	
7	1505. 1	3991. 7	Summit of Mesa.
8	32616	3991. 7	
9	472	3986. 3	
10	9579	3980. 8	
11	1097. 1	3975. 2	
12	3061. 6	3975. 2	
13	1620	3961. 3	
14	35945. 1	3955. 2	
15	6709. 3	3948. 2	
16	25154	3935. 2	Hueco Tanks.
17	892. 9	3935. 2	
18	13890. 8	3935. 2	West edge of Hueco Pass
19	3635. 4	4000. 7	In Hueco Pass.
20	2015. 5	4035. 2	Do.
21	1301. 1	4058. 2	Do.
22	1262. 8	4078	Do.
23	684. 7	4086. 9	Do.
24	2283. 2	4122. 7	Do.
25	1773	4190. 2	Do.
26	994. 9	4245. 1	Do.
27	1224. 5	4289. 9	
28	1989. 8	4623. 9	
29	1791. 4	4762. 4	In Hueco Pass.
30	1530. 7	4811. 8	Summit of Pass.
31	4974. 6	4657	In Hueco Pass.
32	3826. 7	4584. 7	
33	6683. 8	4650. 8	
34	4757. 8	4697. 8	
35	1898. 4	4695. 6	
36	29784. 3	4738. 9	
37	48981. 4	4568	Sierra de los Alamos
38	10765. 7	4659. 4	
39	8881. 3	4502. 9	
40	4234. 8	4568. 1	
41	9247. 8	4543. 9	
42	7053. 9	4371. 6	
43	3061. 4	4361. 8	Los Cornudos.
44	29312. 3	4350	
45	29133. 7	4346. 8	Open plain.
46	6518	4468. 5	
47	4694	4386. 6	
48	9617. 7	4160. 8	
49	19707. 4	4164. 8	
50	16234. 1	3974	
51	7334. 4	3893	Salt Lake.
52	20472. 7	3893	Ojo del Cuerbo.
53	38075. 4	3898	
54	9617. 7	4063	West edge of Guadalupe Pass.
55	3214. 3	4168. 5	In Guadalupe Pass.
56	10382. 9	4422	Do.
57	612. 5	4451. 1	Do.
58	1785. 8	4550. 2	Do.
59	3210. 7	4662. 2	Do.
60	1581. 7	4684. 7	Do.
61	9247. 8	4539. 5	Do.
62	2117	4549. 9	Do.

Altitudes of Stations above the sea-level—Continued.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
63	4592	4437.8	In Guadalupe Pass.
64	1416	4511.4	Do.
65	11224.8	4472.3	Do.
66	2143	4431.2	Foot of Cañon, Guadalupe Pass.
67	18929.2	5619.7	In Guadalupe Pass.
68	1339.4	5659	Do.
69	1951.6	5716.8	Summit of Pass.
70	3269.4	5573.3	In Guadalupe Pass.
71	15038.9	5553.3	Pinery.
72	31442.4	4777.8	Independence Spring.
73	73880.2	4256	
74	5268	4171.8	Head Springs of Delaware creek.
75	50584.9	4421.3	On high land near Delaware creek.
76	30847	4378.6	Do do.
77	11794.8	4505.8	Do do.
78	28457.6	4290.6	Do do.
79	7615.1	4204.3	Do do.
80	29040.3	4069.2	Pecos, mouth of Delaware creek.
81	14533.3	4143.5	Llano Estacado.
82	12133.3	4222.5	Do.
83	10400	4273.3	Do.
84	22533.3	4432.3	Do.
85	57733.3	4599	Do.
86	56800	4706.9	Summit of Llano Estacado.
87	10000	4701.5	Llano Estacado.
88	31700	4612.3	Do.
89	36400	4543.2	Do.
90	27400	4483.7	Do.
91	49533.3	4564.3	Do.
92	27333.3	4654.7	Do.
93	9733.3	4665.2	Do.
94	17600	4627	Do.
95	46800	4563.5	Do.
96	42333.3	4540.6	Do.
97	28866.6	4509.3	Do.
98	14466.6	4485.8	Do.
99	27866.6	4463.2	Do.
100	32666.6	4418.9	Do.
101	16666.6	4409.9	Do.
102	20600	4443.4	Do.
103	23533.3	4430.2	Do.
104	18000	4277.3	Sulphur Springs of the Colorado.
105	15179.1	4343.5	
106	60461.3	4501.6	
107	9798.4	4530.3	
108	15370	4452.7	
109	22577.7	4419.9	Open plain.
110	37692.7	4387.1	
111	40522.3	4162.3	
112	30067	3988.9	Colorado river.
113	31002	4021.1	
114	13520.9	4013.4	
115	45920	4146.9	
116	30868.5	4236.6	Divide of Colorado and Brazos rivers.
117	29975.6	4149.5	
118	11734.9	3875.3	Tributary of Double Mountain fork of the Brazos.
119	24363.3	4023.5	
120	60206.2	3673.3	
121	55861.9	3543.3	
122	53073.6	3359.1	
123	42986.2	3170.6	
124	17985.5	3128.8	
125	15332.2	3021.8	
126	27284.1	2926.6	
127	38643.6	2881.7	
128	22334	2855.8	
129	15814.5	2819	
130	46366.4	2697.7	High lands west of Clear fork of the Brazos

Altitudes of Stations above the sea-level—Continued.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
131	17207.3	2690	High lands west of Clear fork of the Brazos.
132	5740	2646.2	
133	34822	2119.5	Clear fork of the Brazos.
134	23672.2	2314.8	High lands east of Clear fork of the Brazos.
135	14987.6	2277.8	
136	23087.6	2173.8	
137	3316.4	2082.2	
138	22050.3	2091.9	
139	11403.5	2103.5	
140	11901	2046.4	
141	35804.8	1843.4	
142	21301.7	1716.4	High land west of Brazos river.
143	35205.4	1614.1	High land east of Brazos river.
144	3717.8	1611.5	
145	33626.4	1660.4	
146	17666.4	1706.6	Divide of Brazos and Trinity rivers.
147	35588	1524.5	West fork of Trinity.
148	10740	1652.7	
149	21416.6	1640.3	
150	19120.5	1573.6	
151	10003.2	1556.2	
152	8252.8	1539.4	
153	29348.5	1547.9	
154	8482.4	1555.2	
155	15944.4	1559.7	
156	47774.2	1475.9	
157	61170.2	1440.1	
158	18712.3	1434.8	
159	14605.2	1447.5	
160	82400.9	1782.9	East edge of Upper Cross Timbers.
161	38266.9	1716.2	
162	7485	1602.2	Elm fork of Trinity.
163	11507.8	1623.4	
164	42690	1369.6	Clear fork of Trinity.
165	49997.8	1461.7	Hill near Gainesville.
166	14987.8	1540.1	
167	28126	1425.6	
168	23215.1	1364.9	East edge of Lower Cross Timbers.
169	10557.6	1340.4	
170	39414	1227.9	Big Mineral.
171	21557.6	1305	
172	26595.4	1189	High land west of Red river.
173	30423.4	790.2	Preston.
174	----------	641	Red river.

APPENDIX I.

Observations for Determining Profile from El Paso to Preston, on Red River.

		Observations.		Deduced results.		Remarks.
Number of station.		Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
			° ′ ″			
1.	B....	2870	0 36 00	.....	30.4	B. Back sights.
	F....	2334.3	0 54 30	37	.....	F. Front sights.
2.	B....	1287.6	0 19 30	.....	7	
	F....	382.6	1 08 00	7.4		
3.	B....	2793.5	0 19 30	.....	15.4	
	F....	1505.1	3 36 00	94.5		
4.	B....	32616				
	F....	472	0 39 30	.....	5.4	
5.	B....	9579				
	F....	1097	0 35 00	.....	11.1	
6.	B....	3061.6				
	F....	1620	0 29 30	.....	13.9	
7.	F....	35945.1	0 02 30	.....	26.1	
8.	B....	6709.3				
	F....	2515.4				
9.	B....	892.9				
	F....	13890.8				
10.	B....	3635.4	1 02 00	.....	65.5	
	F....	2015.5	0 59 00	34.5		
11.	B....	1301.1	1 01 00	.....	23	
	F....	1262.8	0 54 00	.....	19.8	
12.	B....	684.7	0 45 00	.....	8.9	
	F....	2283.2	0 54 00	35.8		
13.	B....	1773.1	2 11 00	.....	67.5	
	F....	994.9	3 01 00	54.9		
14.	B....	1224.5	2 06 00	.....	44.8	
	F....	1989.8	9 40 00	334.1		
15.	B....	1791.4	4 26 00	.....	138.5	
	F....	1530.7	1 51 00	49.4		
16.	B....	4979.6	1 54 00	164.8		
	F....	3826.7	0 56 00	.....	62.3	
17.	F....	6683.8	0 34 00	66.1		
18.	F....	4757.8	0 34 00	47		
19.	F....	1898.4	0 04 00	.....	2.2	
20.	F....	29784.3	0 05 00	43.3		
21.	F....	48981.4	0 12 00	.....	170.9	
22.	B....	10765.7	0 26 00	.....	81.4	
	F....	8881.3	1 01 00	.....	157.5	
23.	B....	4234.8	0 53 00	.....	65.2	
	F....	9247.8	0 09 00	.....	24.2	
24.	B....	7053.9	1 24 00	172.3		
	F....	3061.4				
25.	B....	29312.3				
	F....	29133.7				
26.	B....	6518.1	0 51 00	.....	96.9	
	F....	4694.1	1 00 00	.....	81.9	
27.	B....	9617.7	1 20 00	223.8		
	F....	19707.4				
28.	B....	16234.1	0 40 00	188.8		
	F....	7334.4	0 38 00	.....	81	
29.	F....	20472.7				
30.	B....	38075.4				
	F....	9617.7	0 59 00	165		
31.	B....	3214.3	1 53 00	.....	105.5	
	F....	10382.9	1 24 00	253.5		
32.	B....	612.5	3 12 00	.....	34.1	
	F....	1785.8	3 11 00	99.1		
33.	B....	3210.7	2 00 00	.....	112	
	F....	1581.7	0 49 00	22.5		

Observations for Determining Profile from El Paso to Preston—Continued.

Observations.				Deduced results.		Remarks.
Number of station.		Distance in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
			° ′ ″			
34.	B	9247.8	0 54 00	145.2		
	F	2117.0	0 17 00	10.4		
35.	B	4592.1	1 24 00	112.1		
	F	1416	2 59 00	73.6		
36.	B	11224.8	0 12 00	39.1		
	F	2143	1 06 00	.....	41.1	
37.	B	18929.2	3 36 00	.....	1188.5	
	F	1339.4	1 41 00	39.3		
38.	B	1951.6	1 42 00	.....	57.8	
	F	3269.4	2 31 00	143.5		
39.	B	8342.2				
	F	4974.7				
40.	F	1722				
41.	B	31442.4	1 27 00	795.5		
42.	B	105322.6	0 43 00	1317.3	.....	To the Pinery.
	F	5268	0 55 00	.....	84.2	
43.	B	161549.2	0 25 00	1174.7	.....	To the Pinery.
44.	B	203897.6	0 18 00	1067.5	.....	To the Pinery.
45.	B	2845.7	0 26 00	215.2		
	F	7615.1	0 39 00	.....	86.3	
46.	F	29040.3	0 16 00	.....	135.1	
47.	B	13564.4	0 04 00	15.7		
	F	11324.4	0 24 00	79		
48.	F	9706.7	0 18 00	50.8		
49.	F	21031	0 26 00	159		
50.	F	53884.4	0 10 00	156.7		
51.	F	53013.4	0 07 00	107.9		
52.	F	9333.6				
53.	F	29586.8	0 11 00	.....	94.6	
54.	F	33973.4	0 07 00	.....	69.1	
55.	F	25573.4	0 08 00	.....	59.5	
56.	F	46231.1	0 06 00	80.6		
57.	F	25511.1	0 13 00	96.4		
58.	F	9084.4	0 04 00	10.5		
59.	F	16426.8	0 08 00	.....	38.2	
60.	F	43680	0 05 00	.....	63.5	
61.	F	39511	0 02 00	.....	22.9	
62.	F	26942.2	0 04 00	.....	31.3	
63.	F	13501.6	0 06 00	.....	23.5	
64.	F	26007.9	0 03 00	.....	22.6	
65.	F	30490.2	0 05 00	.....	44.3	
66.	F	15555.6	0 02 00	.....	9	
67.	F	19226.7	0 06 00	33.5		
68.	F	21964.4				
69.	F	16800	0 34 00	.....	166.1	
70.	F	15179.1	0 15 00	66.2		
71.	F	60461.3	0 09 00	158.1		
72.	F	9798.4	0 10 00	28.7		
73.	B	37947.7	0 10 00	110.4		
	F	37692.7	0 03 00	.....	32.8	
74.	F	40522.3	0 19 00	.....	223.9	
75.	F	61069.1	0 08 00	.....	142.1	
76.	F	13520.9	0 02 00	.....	7.7	
77.	B	45920	0 10 00	.....	133.5	
	F	30868.5	0 10 00	89.7		
78.	F	29975.6	0 10 00	.....	87.1	
79.	F	36098.2	0 12 00	.....	126.1	
80.	F	60206.2	0 20 00	.....	350.2	
81.	F	55861.9	0 08 00	.....	130	
82.	B	53073.6	0 12 00	185.2		
	F	42986.2	0 15 00	.....	187.5	
83.	F	17985.5	0 08 00	.....	41.8	
84.	B	15332.2	0 24 00	107		
	F	27284.1	0 12 00	.....	95.2	

Observations for Determining Profile from El Paso to Preston—Continued.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ′ ″			
85. F	38643.6	0 04 00	.....	44.9	
86. F	22334	0 04 00	.....	25.9	
87. F	15814.5	0 08 00	36.8		
88. B	46366.4	0 09 00	121.3		
F	17207.3				
89. B	64224.2	0 20 30	382.9		
F	14987.8	0 08 30	.....	37	
90. B	23087.6	0 15 30	104		
F	3316.4	0 09 30	.....	91.6	
91. B	23050.3	0 01 30	.....	9.7	
92. B	11403.5	0 03 30	.....	11.6	
93. B	11901	0 16 30	57.1		
F	35804.8	0 19 30	.....	20.3	
94. B	21301.7	0 20 00	127		
95. B	35205.4	0 10 00	102.3		
F	3717.8	0 02 00	.....	2.6	
96. B	33626.4	0 05 00	.....	48.9	
97. B	17666.4	0 09 00	.....	46.2	
98. B	46328.2	0 04 00	53.9		
99. B	21416.6	0 02 00	12.4		
F	19120.5	0 12 00	.....	66.7	
100. F	10013.2	0 06 00	.....	17.4	
101. B	8252.8	0 07 00	16.8		
102. B	29248.5	0 01 00	.....	8.5	
F	8482.4	0 03 00	7.3		
103. B	15944.4	0 01 00	.....	4.5	
104. B	47774.2	0 06 00	83.8		
F	61170	0 02 00	.....	35.8	
105. F	18712.3	0 01 00	.....	5.3	
106. B	14605.2	0 03 00	.....	12.7	
107. B	82400.9	0 14 00	335.4		
108. B	38266.9	0 06 00	66.7		
F	18992.8	0 15 00	.....	82.8	
109. B	92687.8	0 06 00	161.7		
F	14987.8	0 18 00	78.4		
110. B	28126	0 14 00	114.5		
F	23215.1	0 09 00	.....	60.7	
111. F	10557.6	0 08 00	.....	24.5	
112. B	60971.6	0 02 00	35.4		
113. B	26595.4	0 15 00	116		
F	30423.4	0 45 00	.....	398.2	

APPENDIX J.

Observations for Determining the Profile from the Emigrant Crossing of the Pecos to the Big Springs of the Colorado.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ′ ″			
1. B.....	48354.2	0 24 00	.....	337.4	
2. B.....	18470.1	0 15 00	.....	80.5	B. Back sights.
F.....	93013.5	0 06 00	162.3	.....	F. Front sights
3. B.....	19975.2	0 23 00	.....	133.6	
F.....	16263.4	0 12 00	56.7		
4. F.....	5404	0 05 00	7.8		
5. B.....	5574.2	0 01 00	.....	1.6	
F.....	11684.1				
6. B.....	4974.6	0 39 00	.....	56.4	
F.....	14235.2	0 01 00	4.1		
7. B.....	15574.6	0 10 00	.....	45.3	
F.....	11350.3	0 27 00	89.1		
8. B.....	15434.2	0 19 00	85.3		
F.....	39236	0 19 00	.....	216.8	
9. F.....	31442.4	0 07 00	.....	64	
10. F.....	9882.4	0 12 00	.....	33.7	
11. F.....	79722.2	0 03 00	.....	69.5	
12. B.....	66752.6	0 08 00	155.3		
F.....	32812.4	0 11 00	.....	104.9	
13. F.....	12398.4	0 16 00	.....	57.7	
14. B.....	43795.9	0 01 00	.....	12.7	
F.....	34006.3	0 06 00	.....	59.3	
15. F.....	7015.6	0 45 00	.....	74.4	Big Springs of Colorado.

APPENDIX K.

Observations for Determining the Profile through San Augustin Pass of the Organ Mountains.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ′ ″			
1. B.....	8099.8	1 25 00	.....	200.2	B. Back sights.
F.....	1942.7	1 20 00	45.1	.....	F. Front sights.
2. B.....	7653.8	0 50 00	.....	111.3	
F.....	40574.8	0 26 00	306.9		
3. B.....	4540.9	1 30 00	.....	118.7	
F.....	5178.7	2 47 00	251.4		
4. B.....	2104.7	3 57 00	.....	144.9	
F.....	2296	4 37 00	185.2		
5. B.....	1326.6	9 27 00	217.7		
F.....	1288.3	6 02 00	.....	145	
6. B.....	5612.4	4 25 00	422.3		
F.....	1466	3 10 00	.....	80.9	
7. B.....	1755.2	2 30 00	76.5		
F.....	8176.3	1 00 00	.....	142.7	
8. B.....	1657.9	1 27 00	41.3		
F.....	2580.1	1 17 00	.....	48.7	
9. B.....	4490	1 20 00	104.3		
10. B.....	4400.8	0 37 00	47.3		
F.....	11161				
11. B.....	5982.4	0 52 00	.....	90.4	
F.....	2576.6	1 25 00	63.6		
12. B.....	1520	1 11 00	.....	31.3	
F.....	2357.8	0 24 00	16.4		
13. B.....	2946.6	0 22 00	.....	18.8	Ojo de la Soledad.

APPENDIX L.

ASTRONOMICAL OBSERVATIONS.

AT DOÑA ANA, NEW MEXICO, FOR RATING THE CHRONOMETER.

Determination of time, January 28, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	18	04	65	28	00	2	09	17
10	20	37	65	48	30	2	07	45
10	21	35	66	15	40	2	05	44
10	23	49	66	32	30	2	04	30
10	24	21	66	51	30	2	03	05
10	26	47	67	11	30	2	01	32
10	27	17	67	32	00	2	00	00

Determination of time, January 29, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	15	44	65	14	40	2	12	02
10	17	04	65	33	50	2	10	38
10	18	32	65	54	40	2	09	13
10	20	06	66	16	50	2	07	33
10	21	40	66	37	10	2	06	00
10	23	46	67	05	00	2	04	00
10	25	23	67	27	10	2	02	18

Determination of time, January 30, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	26	15	68	07	10	2	01	47
10	27	51	68	27	30	2	00	12
10	30	07	68	56	40	Lost.		
10	32	03	69	21	40	Lost.		
10	33	59	69	46	00	Lost.		
10	35	45	70	06	40	Lost.		
10	37	32	70	29	20	Lost.		

Determination of time, January 31, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	21	18	67	17	40	2	06	46
10	22	46	67	39	00	2	05	10
10	24	14	67	58	00	2	03	44
10	26	01	68	22	10	Lost.		
10	27	32	68	41	40	2	00	27
10	29	22	69	05	40	1	58	38
10	31	18	69	30	40	1	56	54

Determination of time, February 1, 1854.—Equal altitudes of the Sun's upper limb.

Time, a m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	30	30	69	56	10	1	56	48
10	31	55	70	14	20	1	58	38
10	32	08	70	38	40	Lost.		
10	34	28	70	46	10	Lost.		
10	35	49	71	02	30	Lost.		
10	37	12	71	19	10	Lost.		
10	38	24	71	34	20	Lost.		

Determination of time, February 2, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	31	40	70	39	30	1	57	23
10	33	18	71	00	50	1	55	44
10	34	36	71	17	30	1	54	24
10	35	56	71	34	40	1	53	02
10	37	00	71	54	30	1	51	21
10	38	54	72	10	50	Lost.		
10	39	10	72	25	50	Lost.		

Determination of time, February 5, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	35	18	73	09	00 (?)	1	45	38
10	37	05	73	21	40	1	47	07
10	38	26	73	37	50	1	48	26
10	39	44	73	54	00	1	49	59
10	41	18	74	12	40	1	51	17
10	42	36	74	29	00	1	52	38
10	44	06	74	46	30	1	53	36

AT CAMP, FOUR AND TWO-TENTHS MILES EAST OF THE HUECO TANKS.

Determination of latitude, February 22, 1854.—Double altitudes of Sirius, in the east.

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	41	04	80	41	30
7	43	40	80	58	20
7	46	03	81	10	00
7	48	44	81	24	10
7	50	27	81	32	30
7	52	52	81	44	00

Thermometer 42° Fahrenheit.

Heavens very hazy, with heavy clouds.

ASTRONOMICAL OBSERVATIONS—Continued.

STATION ONE AND A HALF MILE EAST OF SIERRA DE LOS ALAMOS.

Determination of time, February 24, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	27	46	84	33	00
10	28	24	84	43	00
10	29	11	84	54	10
10	29	54	85	04	40
10	30	34	85	13	30
10	31	17	85	24	00
10	31	58	85	32	10

Thermometer 66° Fahrenheit.

STATION ON SUMMIT OF SIERRA ALTO.

Determination of time, February 23, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	34	17	85	12	30
10	35	16	85	26	40
10	36	16	85	41	20
10	37	11	85	53	30
10	38	56	86	17	30
10	39	53	86	29	40
10	40	46	86	41	00

Thermometer 58° Fahrenheit.

POINT ABOUT EIGHT AND A HALF MILES FROM THE CERRO ALTO.

Determination of time February 23, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	44	42	85	47	20
1	45	44	85	32	50
1	47	10	85	13	00
1	48	11	84	59	30
1	49	11	84	44	00
1	49	59	84	33	20
1	50	47	84	22	20

Thermometer 58° Fahrenheit.

STATION ONE AND A HALF MILE EAST OF THE SIERRA DE LOS ALAMOS.

DETERMINATION OF LATITUDE.

Determination of time, February 24, 1854.

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	27	46	84	33	00
10	28	24	84	43	00
10	29	11	84	54	10
10	29	54	85	04	40
10	30	34	85	13	30
10	31	17	85	24	00
10	31	58	85	32	10

Thermometer 66° Fahrenheit.

CAMP AT CORNUDOS.

Determination of latitude, February 24, 1854 —*Double altitudes of Sirius, in the east.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	21	28	79	24	40
7	24	08	79	42	30
7	26	17	79	58	40
7	28	20	80	11	40
7	31	05	80	28	00
7	32	23	80	37	40
7	34	00	80	46	30

Thermometer 45° Fahrenheit.

Observations discontinued. Night suddenly clouded up.

Determination of time, February 25, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	22	09	83	57	40
10	23	04	84	10	40
10	23	54	84	23	20
10	24	28	84	32	00
10	25	12	84	43	00
10	25	54	84	53	20
10	26	35	85	04	10

Thermometer 50° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

AT CAMP TWELVE AND ONE-TWENTIETH MILES EAST OF THE CORNUDOS.

DETERMINATION OF LATITUDE.

Determination of time, February 25, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m*	*s.*
1	38	51	88	14	00
1	39	55	87	59	40
1	40	44	87	48	00
1	41	18	87	41	00
1	42	19	87	26	30
1	42	59	87	17	30
1	43	36	87	09	00

Thermometer 51° Fahrenheit.

Determination of latitude, February 25, 1854.—*Double altitudes of Sirius, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	37	25	72	45	30
6	39	16	73	08	10
6	40	48	73	25	10
6	42	44	73	47	20
6	44	51	74	12	40
6	45	58	74	26	30
6	47	05	74	38	10

Double altitudes of Procyon, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	53	09	98	58	20
6	54	22	99	22	40
6	55	54	99	54	30
6	56	54	100	15	00
6	58	18	100	44	00
7	00	58	101	40	00
7	02	33	102	11	40

Thermometer 31° Fahrenheit.

Determination of latitude.—Double altitudes of a Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	41	30	73	07	40
7	43	51	73	43	40
7	45	56	74	09	40
7	49	46	75	03	30
7	51	34	75	29	20
7	52	54	75	45	40
7	55	13	76	20	00

Double altitudes of Polaris, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	27	45	64	14	40
8	30	41	64	09	40
8	33	12	64	08	00

Thermometer 31° Fahrenheit.

Determination of time, February 25, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	38	51	88	14	00
1	39	55	87	59	40
1	40	44	87	48	00
1	41	18	87	41	00
1	42	19	87	26	30
1	42	59	87	17	30
1	43	36	87	09	00

Thermometer 51° Fahrenheit.

BED OF SALT LAKE, THREE MILES WEST OF THE OJO DEL CUERBO.

Determination of time, February 26, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s*
10	34	38	88	02	00
10	35	30	88	13	20
10	36	23	88	24	30
10	37	12	88	37	20
10	38	04	88	47	40
10	38	45	88	57	00
10	39	26	89	06	10

Thermometer 59° Fahrenheit.

CAMP AT OJO DEL CUERBO, FEBRUARY 26, 1854.

Magnetic amplitude of the Sun's centre at his setting..... 22° 00′ 00″ south.
Variation of compass..... 11 09 30 east.

ASTRONOMICAL OBSERVATIONS—Continued.

SAND HILLS, FOUR MILES EAST OF THE OJO DEL CUERBO.

Determination of time, February 27, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	30	51	88	01	40
10	31	32	88	11	30
10	32	15	88	21	20
10	32	51	88	29	30
10	33	30	88	38	40
10	34	10	88	47	40
10	41	43	88	55	40

Thermometer 69° Fahrenheit.

NEAR THE GUADALUPE MOUNTAINS, (WEST SIDE.)

Determination of time, February 28, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	40	37	91	23	20
10	41	46	91	38	00
10	42	30	91	47	30
10	43	08	91	54	30
10	43	50	92	03	40
10	44	24	92	11	00
10	44	58	92	18	10

Thermometer 78° Fahrenheit.

NEAR THE SOUTH POINT OF THE GUADALUPE MOUNTAINS—EAST SIDE.

DETERMINATION OF LATITUDE.

Determination of time, February 28, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	00	49	84	00	00
2	01	40	83	47	00
2	02	22	83	36	30
2	02	54	83	26	20
2	03	39	83	13	40
2	04	14	83	03	20
2	04	53	82	52	40

Thermometer 78° Fahrenheit.

CAMP IN CAÑON NEAR SOUTH POINT OF GUADALUPE MOUNTAINS.

Determination of latitude, February 28, 1854.—Double altitudes of Sirius in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s*
7	29	13	82	21	20
7	30	30	82	26	30
7	31	26	82	31	00
7	32	57	82	35	40
7	34	15	82	40	00
7	35	36	82	45	10

Thermometer 78° Fahrenheit.

NEAR THE SOUTH POINT OF THE GUADALUPE MOUNTAINS—EAST SIDE.

Determination of time, February 28, 1854.—Donble altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	00	49	84	00	00
2	01	40	83	47	00
2	02	22	83	36	30
2	02	54	83	26	20
2	03	39	83	13	30
2	04	14	83	03	20
2	04	53	82	52	40

Thermometer 78° Fahrenheit.

CAMP EAST SIDE OF THE GUADALUPE MOUNTAINS—PINERY.

DETERMINATION OF LATITUDE.

Determination of time, March 1, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	57	41	81	12	10
6	59	08	81	22	30
7	01	10	81	33	30
7	02	17	81	40	10
7	03	29	81	46	00
7	04	36	81	50	10

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of β Orionis, in the west.

Time.			Altitudes.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	
7	51	01	85	54	30	
7	52	58	85	27	20	
7	55	39	84	45	20	
7	57	21	84	20	00	
7	59	44	83	42	40	doubtful.
8	03	28	82	42	30	

Thermometer 40° Fahrenheit.

Determination of latitude, March 1, 1854.—*Double altitudes of Sirius, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	57	41	81	12	10
6	59	08	81	22	30
7	01	10	81	33	30
7	02	17	81	40	10
7	03	29	81	46	00
7	04	36	81	50	10

Double altitudes of Polaris, in the west.

Time.			Altitudes.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	
7	08	42	64	44	20	
7	12	50	64	41	10	
7	16	23	64	38	00	
7	20	28	64	34	00	doubtful.
7	26	05	64	30	40	
7	31	05	64	28	00	

Double altitudes of β Orionis in the west.

Time.			Altitudes.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	
7	51	01	85	54	30	
7	52	58	85	27	20	
7	55	39	84	45	20	
7	57	21	84	20	00	
7	59	44	83	42	40	doubtful.
8	03	28	82	42	30	

Thermometer 40° Fahrenheit.

Note.—Night suddenly clouded up, with high wind.

Determination of time, March 1, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	37	19	87	11	40
1	38	19	86	57	20
1	39	05	86	45	10
1	39	08	86	37	10
1	41	02	86	14	10
1	42	01	85	59	40

Thermometer 59° Fahrenheit.

BED OF DELAWARE CREEK, THIRTEEN MILES FROM INDEPENDENCE SPRINGS.

Determination of time, March 3, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	25	49	90	43	00
1	27	09	90	22	30
1	28	00	90	12	20
1	29	57	89	48	50
1	30	33	89	39	40
1	31	10	89	30	40
1	31	54	89	20	30

Thermometer 55° Fahrenheit.

CAMP AT THE HEAD OF DELAWARE CREEK.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, March 4, 1854.—*Double altitudes of Aldebaran, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Determination of longitude by lunar distances, March 4, 1854.—The Moon's western limb and Aldebaran, east.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	33	36	13	23	40
7	38	45	13	21	00
7	42	57	13	19	10
7	47	55	13	17	10

Double altitudes of the Moon's bright (lower) limb, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	55	52	78	20	20

Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	04	04	95	53	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	07	45	13	10	40
8	12	35	13	08	50
8	17	34	13	06	50
8	22	26	13	04	20

Double altitudes of the Moon's bright (lower) limb, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	26	05	65	25	20

Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	28	49	85	20	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	33	55	13	01	30
8	38	41	12	59	20
8	43	48	12	57	50

Thermometer 37° Fahrenheit.

DETERMINATION OF LATITUDE.

Determination of time, March 3, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	56	31	82	05	40
7	58	15	81	58	00
7	59	31	81	52	10
8	00	48	81	47	00
8	02	16	81	40	40
8	03	41	81	34	20
8	04	53	81	28	00
8	07	26	81	14	40
8	08	54	81	06	20

Double altitudes of α Leonis (Regulus,) in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	36	23	107	15	00
8	38	22	107	48	40
8	39	39	108	21	00
8	41	09	108	54	40
8	42	26	109	22	20
8	43	59	109	58	30
8	45	45	110	37	40
8	47	24	111	17	00
8	48	50	111	50	20

Thermometer 32° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, March 3, 1854.—*Double altitudes of α Ursæ Majoris, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	06	50	74	11	40
7	10	25	75	00	30
7	12	00	75	21	30
7	14	15	75	52	30
7	16	15	76	21	30
7	17	48	76	43	00

Double altitudes of α Leonis (Regulus) in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	36	23	107	15	00
8	38	22	107	48	40
8	39	39	108	21	00
8	41	09	108	54	40
8	42	26	109	22	20
8	43	59	109	58	30
8	45	45	110	37	40
8	47	24	111	17	00
8	48	50	111	50	20

Double altitudes of Polaris, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	28	12	63	43	40
7	32	55	63	40	10
7	37	55	63	37	00
7	42	05	63	34	00
7	46	48	63	30	20
7	51	53	63	26	40

Thermometer 32° Fahrenheit.

Determination of latitude, March 3, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	56	31	82	05	40
7	58	15	81	58	00
7	59	31	81	52	10
8	00	48	81	47	00
8	02	16	81	40	40
8	03	41	81	34	20
8	04	53	81	28	00
8	07	26	81	14	40
8	08	54	81	06	20

Double altitudes of β Orionis, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	13	27	76	26	40
8	15	08	75	56	30
8	16	25	75	34	00
8	18	37	74	53	20
8	20	22	74	21	00
8	22	11	73	47	30
8	23	43	73	18	40
8	24	53	72	56	40

Thermometer 32° Fahrenheit.

Determination of time, March 4, 1854.—*Double altitudes of Aldebaran, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Determination of latitude, March 4, 1854.—*Double altitudes of Aldebaran, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Capella, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	57	28	103	05	00
8	58	50	102	37	20
9	00	39	101	57	10
9	01	40	101	36	20
9	02	40	101	26	00

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Meridian altitude of Sirius.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	22	32	82	57	00

Magnetic amplitude of the Sun's centre at his setting, 20° south.

Determination of time, March 4, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	26	56	95	26	10
10	28	23	95	45	00
10	29	29	95	59	40
10	30	44	96	14	00
10	31	56	96	29	30
10	33	14	96	44	20
10	34	24	96	58	30

Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	24	28	91	05	40
1	25	28	90	50	00
1	26	19	90	37	40
1	27	15	90	24	00
1	27	57	90	03	50
1	28	46	90	01	10
1	29	37	89	47	00
1	30	23	89	35	10
1	30	57	89	27	00
1	31	33	89	17	30

Thermometer 60° Fahrenheit.

CAMP ON DELAWARE CREEK.

Observations for the variation of the compass, March 7, 1854.

Magnetic amplitude of the Sun's centre at his setting - - - - - - 18° 00′ 00″ south.
Variation - - - - - - - 11 53 00

FALLS OF THE PECOS, MOUTH OF THE DELAWARE CREEK.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, March 10, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	01	04	67	42	05
9	02	18	67	24	25
9	03	24	67	08	05
9	04	29	66	53	05
9	05	36	66	35	25
9	06	54	66	16	45
9	07	50	66	02	35
9	08	47	65	48	45
9	09	56	65	30	55
9	10	58	65	15	25

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	20	38	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.

Determination of longitude by lunar distances, March 10, 1854.—*The Moon's western limb and Spica Virginis, in the east.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	06	06	73	35	35
11	10	53	73	32	25
11	15	35	73	29	55
11	20	48	73	28	35 doubtful.

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	25	40	118	52	25

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	33	27	75	26	25

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	37	51	73	14	15
11	42	54	73	11	15
11	47	52	73	08	35
11	52	52	73	06	25

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	55	00	106	39	35

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	58	01	81	49	55

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	01	14	73	03	05
12	06	14	73	00	55
12	11	13	72	58	55
12	16	20	72	56	55

Thermometer 42° Fahrenheit.

Determination of time, March 14, 1854.—*Double altitudes of Capella, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	84	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Thermometer 49° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of longitude by lunar distances, March 14, 1854.—*The Moon's western limb and Spica Virginis, east.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	52	08	22	08	15
10	56	30	22	05	35
11	00	40	22	03	55
11	04	35	22	01	25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	07	50	114	46	25

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	14	42	75	26	25

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	16	22	21	56	45
11	19	29	21	55	25
11	22	34	21	54	05
11	25	28	21	52	35

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	31	43	80	00	25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	33	48	119	34	45

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	36	28	21	48	35
11	39	22	21	46	55
11	42	22	21	45	35
11	45	23	21	44	35

Thermometer 49° Fahrenheit.

Determination of time, March 16, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	25	49	70	26	50
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	50

Thermometer 52½° Fahrenheit.

Determination of longitude by lunar distances, March 16, 1854.—*The Moon's western limb and Mars, west.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	39	12	58	10	20
11	45	05	58	13	00
11	50	07	58	15	30
11	55	09	58	17	40

Double altitude of the Moon's bright (lower) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	57	51	81	17	30

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of Mars, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	59	58	123	02	30

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	02	39	58	20	00
12	06	37	58	22	00
12	10	26	58	24	00
12	13	58	58	25	50

Double altitude of Mars, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	17	58	116	20	00

Double altitude of the Moon's bright (lower) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	20	45	86	38	00

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	22	59	58	29	20
12	26	31	58	30	40
12	30	16	58	32	00
12	34	10	58	33	30

Thermometer 52½° Fahrenheit.

***Determination of latitude, March** 10, 1854.—Double altitudes of Capella, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	43	18	101	30	55
8	45	14	100	50	55
8	47	11	100	09	15
8	48	28	99	43	05
8	49	51	99	14	45
8	51	17	98	46	25
8	52	46	98	06	25
8	53	52	97	44	25
8	55	40	97	04	45
8	56	41	96	43	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	20	38	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.
NOTE.—Northern heavens very hazy.

***Determination of time, March** 14, 1854.—Double altitudes of Capella, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	84	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Thermometer 49° Fahrenheit.

***Determination of latitude, March** 14, 1854.—Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	23	34	62	13	45
10	28	08	62	10	35
10	32	36	62	08	35
10	38	04	62	04	45
10	43	32	62	02	05

Northern stars clouded up.

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	41	10	68	23	55
8	42	54	67	58	35
8	43	57	67	43	05
8	45	01	67	27	55
8	45	59	67	13	05
8	47	08	66	56	25
8	48	11	66	41	05
8	49	38	66	19	25

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	21	11	108	42	35
9	22	27	108	19	55
9	23	29	108	00	45
9	24	36	107	39	25
9	25	39	107	18	25
9	26	30	107	02	25
9	27	28	106	43	55
9	28	47	106	18	05

Thermometer 49° Fahrenheit.

Determination of latitude, March 14, 1854.—*Double altitudes of Capella, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Thermometer 49° Fahrenheit.

Determination of latitude, March 14, 1854.—*Double altitudes of Spica Virginis, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	85	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
12	01	20	115	35	35
12	02	34	116	06	25
12	03	55	116	40	25
12	04	54	117	04	35
12	06	11	117	35	25
12	07	09	117	59	35
12	08	07	118	23	05
12	09	01	118	44	55
12	09	55	119	07	25
12	10	45	119	27	05

Thermometer 49° Fahrenheit.

Northern heavens clouded up.

Determination of latitude, March 16, 1854.—*Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	37	54	63	31	40
7	42	12	63	27	40
7	46	35	63	24	30
7	50	18	63	22	00
7	53	57	63	19	10

Double altitudes of Capella, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	41	33	93	56	30
8	43	00	93	24	00
8	44	02	93	02	50
8	45	02	92	41	50
8	46	11	92	18	30
8	47	46	91	45	20
8	49	04	91	18	10
8	50	28	90	48	00

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	57	10	114	03	50
8	58	12	113	46	40
8	59	11	113	31	00
9	00	35	113	06	00
9	01	42	112	46	20
9	03	10	112	20	10

Thermometer 52½° Fahrenheit

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, March 16, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	25	49	70	26	30
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	58

Thermometer 52½° Fahrenheit.

Determination of latitude.—Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	14	02	76	43	50

Thermometer 52½° Fahrenheit.

NOTE.—This star was so near the moon, it was impossible to get any more observations upon it.

Determination of time, March 9, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	19	23	96	28	35	1	16	44
10	20	25	96	43	35		clouds.	
10	21	13	96	55	05		clouds	
10	21	59	97	05	35	1	14	07
10	22	50	97	17	05	1	13	20
10	23	42	97	28	55	1	12	28
10	24	31	97	41	15	1	11	36
10	25	22	97	52	15	1	10	40
10	26	15	98	04	35	1	09	53
10	27	07	98	16	05		lost.	

Thermometer 77° Fahrenheit.

Observations for the variation of compass.

Magnetic amplitude of the Sun's centre at his setting, 17° 30′ south.

Determination of time, March 10, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	24	09	98	00	05	1	13	59
10	25	03	98	12	25	1	13	04
10	25	47	98	22	45	1	12	17
10	26	36	98	34	55	1	11	24
10	27	29	98	47	05	1	10	33
10	28	14	98	57	05	1	09	54
10	29	07	99	08	25	1	08	55
10	29	53	99	18	05	1	08	06

Thermometer 67° Fahrenheit.

Determination of time, March 11, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	34	04	101	19	55	1	00	52
10	34	58	101	31	25	12	59	53
10	35	52	101	43	45	12	58	51
10	36	49	101	54	25	12	58	00
10	37	48	102	06	25	12	57	03
10	38	44	102	18	25	12	56	02
10	39	45	102	29	35	12	55	04
10	40	43	102	41	05	12	54	08
10	41	40	102	51	35	12	53	05
10	42	43	103	03	45	12	52	04

Thermometer 73° Fahrenheit.

Determination of time, March 15, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	17	55	100	24	40	1	15	58
10	18	43	100	38	20	1	15	05
10	19	35	100	50	10	1	14	17
10	20	11	100	59	10	1	13	38
10	21	02	101	12	20	1	12	46
10	21	47	101	22	40	1	12	01
10	22	37	101	34	50	1	11	13
10	23	38	101	48	50	1	10	11
10	24	20	101	59	20	1	09	30
10	25	17	102	12	20	1	08	35

Thermometer 83° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of time, March 16, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	15	28	100	17	30	1	20	06
10	16	17	100	29	10	1	19	16
10	17	10	100	43	00	1	18	22
10	17	56	100	53	50	1	17	39
10	18	43	101	06	20	1	16	52
10	19	34	101	18	20	1	16	03
10	20	36	101	35	20	1	14	55
10	21	30	101	48	20	1	14	02

Thermometer 89° Fahrenheit.

OBSERVATIONS FOR THE VARIATION OF COMPASS.

Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
8	30	27	69	24	20	S. 21	30	00	W.

Double altitude of Polaris, in the east.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	37	54	63	31	40	N. 14	00	00	W.

Thermometer 52½° Fahrenheit.

Determination of time, March 18, 1854.

Time, a. m.			Altitudes.			Time. p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m*	*s.*
10	42	43	108	17	40	12	49	32
10	43	34	108	27	40	Lost.		
10	44	34	108	38	50	Lost.		
Clouds for a few moments.								
10	47	39	109	12	40	12	44	27
10	48	14	109	21	00	12	43	38
10	49	03	109	29	30	12	42	54
10	49	45	109	36	40	12	42	29
10	50	30	109	44	40	12	41	46

Thermometer 82° Fahrenheit.

SULPHUR SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Determination of time, April 5, 1854.—*Double altitudes of Sirius, in the west.*

Approximate latitude, 32° 28′ 55″.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	23	20
6	45	20	72	11	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	22	36	88	33	00
9	23	51	89	06	20
9	24	40	89	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Thermometer 46½° Fahrenheit.

Determination of latitude, April 5, 1854.—*Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	54	50	63	48	50
6	57	31	63	46	10
7	00	34	63	43	30
7	04	01	63	41	50
7	09	50	63	37	30
7	12	42	63	35	50
7	15	45	63	34	00
7	18	43	63	32	20

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	22	20
6	45	20	72	11	10

Thermometer 46½° Fahrenheit.

Double altitudes of Capella, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	13	44	73	03	50
8	14	40	72	44	40
8	15	53	72	19	50
8	16	40	72	01	50
8	17	43	71	42	20
8	18	54	71	18	40
8	19	44	71	01	40
8	20	54	70	36	50
8	21	47	70	18	40
8	22	37	70	02	10

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	26	29	94	29	10
8	27	36	94	04	30
8	28	31	93	44	20
8	29	25	93	24	20
8	30	28	93	01	40
8	31	24	92	40	20
8	32	36	92	14	40
8	33	41	91	51	20
8	34	48	91	26	20
8	35	46	91	05	00

Thermometer 46½° Fahrenheit.

Double altitudes of a Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	59	05	117	41	30
8	01	08	118	00	10
8	02	29	118	12	20
8	03	42	118	22	40
8	04	44	118	32	10
8	05	38	118	39	40
8	06	35	118	49	00
8	07	41	118	57	10
8	08	45	119	05	30
8	09	52	119	14	50

Double altitudes of η Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	41	06	94	53	20
8	42	08	95	12	50
8	43	15	95	34	40
8	44	27	95	57	10
8	45	25	96	16	00
8	46	27	96	36	10
8	47	28	96	56	00
8	48	29	97	14	40
8	49	24	97	32	30
8	50	33	97	55	10

Thermometer 46½° Fahrenheit.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	22	36	88	33	00
9	23	51	89	06	20
9	24	40	89	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	59	45	91	27	40
11	00	50	91	36	10
11	01	45	91	43	20
11	02	39	91	50	10
11	03	40	91	56	40
11	04	36	92	03	30
11	05	35	92	10	10
11	06	25	92	15	30
11	07	13	92	21	30
11	08	06	92	26	10

Thermometer 46½° Fahrenheit.

Determination of time, April 6, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	51	09	70	12	30
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Determination of latitude, April 6, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	04	32	63	40	20
7	06	55	63	39	30
7	10	11	63	36	50
7	12	31	63	35	40
7	15	35	63	33	40
7	17	40	63	32	00
7	19	35	63	30	00
7	21	36	63	28	30
7	23	50	63	27	00
7	26	01	63	25	50

Double altitudes of Capella, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	29	06	87	14	10
7	30	14	86	49	30
7	31	15	86	28	00
7	32	20	86	05	10
7	33	12	85	48	10
7	34	07	85	29	20
7	35	04	85	09	00
7	36	00	84	49	40
7	36	53	84	31	30
7	37	43	84	13	30

Thermometer 58° Fahrenheit.

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	06	11	100	23	40
8	08	25	99	36	00
8	09	35	99	12	50
8	10	29	98	54	30
8	11	30	98	31	30
8	12	28	98	12	00
8	13	24	97	51	10
8	14	14	97	34	10
8	15	40	97	02	40
8	16	34	96	44	00

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	51	09	70	12	30
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Thermometer 58° Fahrenheit.

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	41	38	111	43	00
7	42	48	111	53	50
7	43	54	112	03	50
7	45	08	112	13	20
7	46	14	112	23	30
7	47	21	112	33	40
7	48	23	112	40	40
7	49	22	112	49	20
7	50	21	112	58	10
7	51	35	113	08	10

Double altitudes of η Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	.	*d.*	*m.*	*s.*
7	55	11	81	16	40
7	56	21	81	38	20
7	57	20	81	58	00
7	58	12	82	15	10
7	59	09	82	33	40
8	00	07	82	52	10
8	00	59	83	08	30
8	01	50	83	25	40
8	02	41	83	42	10
8	03	36	83	59	30

Thermometer 58° Fahrenheit.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	33	51	73	50	30
9	34	44	74	05	40
9	35	43	74	22	30
9	36	38	74	37	00
9	37	39	74	54	30
9	38	36	75	10	10
9	39	35	75	26	00
9	40	32	75	41	40
9	41	29	75	57	30
9	42	34	76	15	10

Thermometer 58° Fahrenheit.

Determination of time, April 8, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	47	03	69	50	35
6	48	16	69	33	55
6	49	13	69	22	35
6	50	16	69	07	55
6	51	21	68	52	45
6	52	21	68	39	05
6	53	24	68	25	25
6	54	43	68	08	45
6	55	43	67	52	15
6	56	47	67	37	35

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	18	28	90	42	55
9	20	43	91	40	35
9	21	46	92	07	35
9	22	35	92	28	05
9	23	31	92	52	40
9	24	23	93	14	05
9	25	16	93	36	15
9	26	20	94	02	45
3	27	16	94	26	35
9	28	10	94	50	25

Thermometer 50° Fahrenheit.

Determination of latitude, April 8, 1854.—*Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	11	39	63	30	35
7	14	08	63	28	55
7	16	30	63	27	25
7	18	52	63	27	55
7	21	59	63	24	25
7	26	21	63	21	35
7	28	26	63	19	55
7	31	07	63	17	55
7	33	09	63	16	15
7	35	25	63	14	45
7	37	45	63	13	05
7	39	56	63	11	55
7	42	09	63	10	25
7	44	08	63	08	55
7	47	00	63	06	35
7	49	37	63	04	45
7	52	05	63	03	25
7	54	04	63	02	35
7	57	47	63	01	05
7	59	50	62	59	55

Thermometer 50° Fahrenheit.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	31	54	74	51	55
9	32	56	75	09	35
9	34	00	75	26	55
9	35	12	75	46	25
9	36	06	76	01	45
9	36	53	76	13	35
9	38	07	76	34	05
9	39	05	76	48	45
9	40	03	77	04	15
9	41	01	77	20	25
9	43	10	77	54	35
9	44	15	78	10	05
9	45	24	78	29	15
9	46	32	78	44	55
9	47	27	79	00	45
9	48	30	79	15	55
9	49	27	79	30	05
9	50	23	79	43	55
9	51	29	80	01	15
9	52	28	80	14	55
9	53	41	80	32	25
9	54	31	80	44	55

Thermometer 50° Fahrenheit.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, April 3, 1854.—*Double altitudes of Sirius, in the west.*

Approximate latitude, 32° 28′ 55″.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	34	29	74	39	40
6	35	52	74	24	20
6	37	03	74	10	50
6	38	34	73	54	50
6	39	37	73	42	40
6	40	32	73	32	50

17 e

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Arcturus, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	47	16	72	45	10
8	28	21	73	13	20
8	49	17	73	37	30
8	50	20	74	03	50
8	51	18	74	27	50
8	52	38	75	01	30

Thermometer 62½° Fahrenheit.

Determination of longitude by lunar distances, April 3, 1854.—The Moon's western limb and Saturn, west.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	46	39	39	37	20
6	49	39	39	38	40
6	52	22	39	39	50
6	55	25	39	40	50

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	57	24	132	13	50

Double altitude of Saturn, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	00	32	53	07	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	02	26	39	43	00
7	05	08	39	44	00
7	08	11	39	45	10
7	11	32	39	46	20

Double altitude of Saturn, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	13	47	47	36	10

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	15	18	124	54	50

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	16	56	39	48	30
7	19	58	39	49	40
7	22	50	39	50	50
7	25	54	39	51	40

Thermometer 62½° Fahrenheit.

The Moon's western limb and Aldebaran, west.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	27	51	31	51	50
7	30	44	31	52	50
7	33	41	31	53	50
7	36	35	31	54	50

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	38	20	115	27	40

Double altitude of Aldebaran, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	41	30	50	32	20

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	43	23	31	57	20
7	46	20	31	58	50
7	49	20	31	59	50
7	52	18	32	01	00

Double altitude of Aldebaran, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	54	11	45	12	20

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	55	52	108	13	50

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	57	39	32	02	40
8	00	28	32	03	30
8	03	22	32	04	40
8	06	20	32	05	50

Thermometer 62½° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of time, April 5, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	23	20
6	45	20	72	11	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	22	36	88	33	00
9	23	51	88	06	20
9	24	40	88	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Thermometer 46½° Fahrenheit.

Determination of longitude, April 5, 1854.—*The Moon's western limb and Aldebaran, west.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	28	08	43	48	20
7	29	26	43	48	50
7	31	03	43	49	20
7	32	00	43	49	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	33	59	138	16	10

Double altitude of Aldebaran, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	36	24	51	49	10

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	37	55	43	50	50
7	39	27	43	51	20
7	40	40	43	52	10
7	41	29	43	53	00

Double altitude of Aldebaran, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	43	55	48	41	00

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	46	20	133	15	50

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	48	28	43	54	40
7	49	33	43	55	00
7	50	25	43	55	30
7	51	25	43	55	50

Thermometer 46½° Fahrenheit.

The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	49	58	90	24	50
9	51	18	90	23	50
9	52	25	90	23	20
9	53	25	90	22	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	55	38	80	06	00

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	57	30	79	12	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	59	31	90	20	00
10	01	12	90	19	20
10	02	34	90	18	40
10	04	03	90	18	10

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	07	03	81	31	30

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	09	05	74	36	50

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	10	52	90	15	20
10	12	38	90	14	30
10	14	30	90	13	20
10	16	26	90	12	40

Thermometer 46½° Fahrenheit.

Determination of time, April 6, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
9	56	10	112	38	20	1	05	29
9	56	56	112	52	40	1	04	40
9	57	33	113	03	30	1	04	05
9	58	15	113	15	30	1	03	25
9	58	57	113	28	40	1	02	27
9	59	41	113	41	40	1	01	56
10	00	24	113	53	10	1	01	19
10	01	09	114	07	10	1	00	30
10	01	43	114	18	00	12	59	55
10	02	27	114	30	50	12	59	10

Thermometer 92° Fahrenheit.

Determination of longitude by lunar distances, April 6, 1854.—*Moon's western limb, and nearest limb of the Sun, west.*

Time, p. m.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	25	26	104	02	40
2	27	48	104	03	30
2	30	12	104	04	10
2	31	50	104	05	00

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	35	49	69	45	30

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	37	05	79	51	20

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	38	20	104	06	50
2	39	38	104	07	20
2	40	59	104	08	10
2	42	24	104	09	00

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	43	44	77	12	50

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	45	34	73	45	20

ASTRONOMICAL OBSERVATIONS—Continued.

Moon's western limb and nearest limb of the Sun.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
2	47	02	104	09	50
2	48	25	104	10	40
2	49	56	104	11	10
2	51	25	104	11	50

Thermometer 58° Fahrenheit.

Second series.—April 6, 1854.

Time, p. m.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	15	16	104	20	10
3	17	12	104	20	40
3	19	08	104	21	10
3	20	51	104	21	30

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	27	01	90	44	00

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	2		59	01	30

Time.			Angular distances		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	29	36	104	23	30
3	30	52	104	24	20
3	32	25	104	25	10
3	33	51	104	25	50

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	35	00	56	18	20

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	36	43	94	43	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	38	03	104	26	40
3	39	37	104	27	20
3	40	56	104	28	00
3	42	41	104	28	50

Thermometer 58° Fahrenheit.

Determination of longitude by lunar distances, April 6, 1854.—*The Moon's western limb and Spica Virginis, east.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	02	43	78	40	00
9	04	30	78	39	10
9	07	08	78	38	30
9	09	06	78	37	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	10	29	117	52	40

Double altitudes of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	12	09	67	23	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	14	23	78	3[illegible]	40
9	16	08	78	35	00
9	18	03	78	34	20
9	19	57	78	33	30

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of Spica Virginis in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	21	34	70	15	40

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	23	33	112	30	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	25	01	78	30	50
9	27	35	78	30	00
9	29	30	78	29	20
9	31	41	78	28	30

Thermometer 58° Fahrenheit.

Second series, April 6, 1854.—The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	50	03	78	22	30
9	51	58	78	21	30
9	53	47	78	20	40
9	55	36	78	19	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	57	05	98	39	20

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	59	21	80	32	40

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	00	53	78	17	10
10	02	58	78	16	20
10	04	53	78	15	30
10	07	00	78	14	50

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	09	00	82	49	20

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	11	08	92	51	00

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	12	37	78	13	00
10	14	50	78	12	00
10	17	00	78	11	00
10	18	58	78	10	10

Thermometer 58° Fahrenheit.

Determination of time, April 8, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	17	45	119	33	55	12	46	52
10	18	25	119	44	35	12	46	06
10	19	03	119	54	35	12	45	27
10	19	41	120	04	35	12	44	50
10	20	21	120	14	45	12	44	08
10	21	10	120	27	45	12	43	20
10	21	56	120	39	05	12	42	33
10	22	42	120	51	05	12	41	45
10	23	30	121	03	05	12	40	57
10	24	25	121	13	35	12	40	13

Thermometer 80° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of longitude by lunar distances, April 8, 1854.—Moon's western limb and nearest limb of the Sun, west.

Time, p. m.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	35	18	127	04	05
3	36	50	127	04	35
3	38	00	127	05	15
3	39	05	127	05	45

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	47	08	53	40	35

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	50	03	51	25	45

Time, p. m.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
3	53	34	127	10	55
3	55	41	127	11	55
3	57	34	127	12	35
3	58	51	127	13	05

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
4	00	33	47	05	10

Double altitude of the moon's bright (upper) limb, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
4	02	39	59	00	05

Time, p. m.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
4	05	30	127	15	15
4	07	44	127	16	05
4	09	30	127	16	45
4	11	05	127	17	35

Thermometer 50° Fahrenheit.

Determination of longitude by lunar distances, April 8, 1854.—The Moon's western limb and Pollux, west.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	58	56	37	18	05
10	01	00	37	19	05
10	02	42	37	20	05
10	04	38	37	21	35

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	06	43	126	32	25

Double altitude of Pollux, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	13	29	71	28	25

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	16	29	37	26	25
10	18	29	37	27	25
10	20	13	37	28	15
10	22	01	37	28	55

Double altitude of Pollux, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	26	38	66	04	55

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	28	25	118	34	45

ASTRONOMICAL OBSERVATIONS—Continued.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	32	58	37	31	25
10	34	43	37	32	15
10	36	50	37	33	05
10	39	03	37	33	55

Thermometer 50° Fahrenheit.

The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	46	20	53	10	45
10	48	13	53	10	05
10	50	02	53	09	15
10	52	02	53	08	35

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	53	31	108	52	15

Double altitude of Spica Virginis, in the east.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	55	54	91	53	25

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
10	57	50	53	07	05
10	59	38	53	06	15
11	01	34	53	05	35
11	03	46	53	04	55

Double altitude of Spica Virginis, in the east.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	06	05	92	57	00

Double altitude of the Moon's bright (lower) limb, in the west.

h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	08	49	102	47	45

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
11	10	30	53	00	45
11	12	32	53	00	05
11	14	54	52	59	15
11	17	15	52	58	45

Thermometer 50° Fahrenheit.

DETERMINATION OF TIME AND RATE OF CHRONOMETER.

Determination of time, April 3, 1854.—*Equal altitudes of Sun's upper limb.*

Approximate latitude to be used in the first computation of time, 32° 28′ 55″.

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
9	57	56	111	03	00	1	04	11
9	58	38	111	15	20		Lost.	
9	59	18	111	27	00		Lost.	
9	59	59	111	38	20	1	02	12
10	00	41	111	50	50	1	01	27
10	01	30	112	05	20	1	00	35
10	02	28	112	21	40	12	59	32
10	03	27	112	37	30	12	58	43

Thermometer 79° Fahrenheit.

Determination of time, April 4, 1854.—*Double altitudes of the Sun's upper limb.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	55	50	111	53	25
9	56	37	112	07	35
9	57	26	112	20	55
9	58	15	112	35	35
9	59	04	112	49	45
9	59	50	113	03	15
10	00	48	113	20	05
10	01	39	113	34	25
10	02	24	113	46	45
10	03	09	113	59	55

Thermometer 78° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of time, April 5, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	09	14	115	49	15	12	52	07
10	09	53	115	59	45	12	51	28
10	10	36	116	11	05	12	50	44
10	11	24	116	24	35	12	50	00
10	12	25	116	40	25	12	48	59
10	13	14	116	54	35	12	48	05
10	14	07	117	07	55	12	47	12
10	14	58	117	21	25	12	46	22
10	15	46	117	33	55	12	45	35
10	16	33	117	46	25	12	44	42

Thermometer 84° Fahrenheit.

Determination of time, April 6, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
9	56	10	112	38	20	1	05	29
9	56	56	112	52	40	1	04	40
9	57	33	113	03	30	1	04	05
9	58	15	113	15	30	1	03	25
9	58	57	113	28	40	1	02	27
9	59	41	113	41	40	1	01	56
10	00	24	113	53	10	1	01	19
10	01	09	114	07	10	1	00	30
10	01	43	114	18	00	12	59	55
10	02	27	114	30	50	12	59	10

Thermometer 92° Fahrenheit.

Determination of time, April 7, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	00	16	114	24	55	1	01	29
10	01	05	114	40	45	1	00	38
10	01	58	114	55	25	12	59	50
10	02	37	115	06	55	12	59	07
10	03	20	115	19	25	12	58	25
10	03	57	115	29	55	12	57	50
10	04	35	115	41	15	12	57	08
10	05	26	115	55	25	12	56	15
10	06	08	116	07	45	12	55	30
10	09	08	116	24	45	12	54	38

Thermometer 91° Fahrenheit.

Determination of time, April 8, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
10	17	45	119	33	55	12	46	52
10	18	25	119	44	35	12	46	06
10	19	03	119	54	35	12	45	27
10	19	41	120	04	35	12	44	50
10	20	21	120	14	45	12	44	08
10	21	10	120	27	45	12	43	20
10	21	56	120	39	05	12	42	33
10	22	42	120	51	05	12	41	45
10	23	30	121	03	05	12	40	57
10	24	15	121	13	35	12	40	13

Thermometer 80° Fahrenheit.

Determination of time, April 9, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
9	52	45	112	35	10	1	13	53
9	53	23	112	46	40	1	13	18
9	53	57	112	57	30	1	12	42
9	54	34	113	09	30	1	12	04
9	55	12	113	21	10	1	11	28
9	55	44	113	31	20	1	10	55
9	56	19	113	42	50	1	10	19
9	57	01	113	55	50	1	09	36
9	57	35	114	06	50	1	09	03
9	58	13	114	17	30	1	08	25
9	58	50	114	28	40	1	07	48
9	59	29	114	42	00	1	07	08
10	00	07	114	52	50	1	06	30
10	00	44	115	04	20	1	05	55
10	01	24	115	16	10	1	05	15
10	02	04	115	28	10	1	04	33
10	02	53	115	42	10	1	03	45
10	03	31	115	54	20	1	03	06
10	04	10	116	05	50	1	02	27
10	04	07	116	16	40	1	01	50

Thermometer 62½° Fahrenheit.

Determination of time, April 10, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	57	53	64	52	50
6	58	57	64	31	29
6	59	59	64	18	30
7	00	55	64	04	50
7	01	56	63	49	20
7	02	45	63	35	40
7	03	34	63	23	30
7	04	34	63	08	10
7	05	23	62	55	00
7	06	16	62	39	50

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	39	26	78	37	20
8	40	22	79	00	50
8	41	10	79	21	20
8	41	59	79	41	40
8	42	42	80	00	00
8	43	37	80	23	30
8	44	28	80	44	40
8	45	21	81	07	30
8	46	14	81	29	50
8	46	55	81	47	20

Thermometer 49½° Fahrenheit.

Determination of time, April 11, 1854.—*Equal altitudes of the Sun's upper limb.*

Time, a. m.			Altitudes.			Time, p. m.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
9	45	14	112	09	00	1	15	41
9	45	58	112	22	40	1	15	01
9	46	38	112	35	30	1	14	24
9	47	16	112	48	10	1	13	44
9	47	56	113	00	50	1	13	04
9	48	32	113	12	40	1	12	28
9	49	08	113	24	40	1	11	51
9	49	53	113	38	40	1	11	08
9	50	29	113	50	10	1	10	33
9	51	04	114	02	00	1	09	52
9	51	38	114	13	30	1	09	13
9	52	17	114	24	40	1	08	43
9	52	48	114	35	30	1	08	10
9	53	22	114	45	40	1	07	39
9	53	58	114	57	40	1	06	58
9	54	45	115	12	20	1	06	14
9	55	13	115	22	20	1	05	41
9	56	07	115	37	00	1	04	57
9	56	48	115	50	00	1	04	11
9	57	24	116	00	40	1	03	37
9	58	01	116	13	20	1	02	55

Thermometer 87° Fahrenheit.

Magnetic amplitude of the sun's centre at his setting, 1° 30′ north.

Observations for the variation of the compass.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	11	10	63	21	50	N. 13	10	00	W.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
9	08	08	71	41	30	S. 55	30	00	E.

CAMP ON RIO PECOS, MARCH 20, 1854.

Observations for the variation of the compass.

Magnetic amplitude of the Sun's centre at his setting, 11° 45′ south.

CAMP ON RIO PECOS, SEVENTY-SIX MILES BELOW MOUTH OF DELAWARE CREEK.

Determination of time, March 23, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	04	58	108	58	05
1	06	01	108	42	35
1	06	53	108	29	35
1	07	50	108	15	05
1	08	35	108	02	55
1	09	34	107	47	35
1	10	19	107	36	15
1	11	23	107	19	05

Thermometer 82° Fahrenheit.

CAMP ON MARCY'S TRAIL, FIFTEEN MILES FROM EMIGRANT'S CROSSING OF THE RIO PECOS, (EAST.)

DETERMINATION OF LATITUDE.

Determination of time, March 24, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	27	18	103	23	35
1	27	57	103	11	15
1	28	35	103	01	25
1	29	14	102	50	25
1	29	51	102	38	05
1	30	34	102	25	45

Thermometer 88° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, March 24, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	
6	41	58	82	33	55	
6	43	41	82	23	05	
6	44	55	82	17	15	
6	46	18	82	09	05	
6	47	30	82	00	05	
6	48	21	81	58	05	d'btful.
6	49	35	81	50	55	
6	50	39	81	44	55	

Double altitude of a Ursæ Majoris, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	37	12	98	33	05

Observations discontinued; the heavens suddenly clouded up.

Observations for the variation of the compass.—Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
6	41	58	82	33	55	S. 00	30	00	W.

Thermometer 72° Fahrenheit.

POINT ON EAST RIDGE OF THE SAND HILLS.

Determination of time, March 27, 1854.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	56	14	103	20	40
9	56	56	103	33	10
9	57	35	103	44	50
9	58	22	103	59	20
9	59	20	104	17	10
10	00	04	104	30	20
10	00	45	104	42	00
10	01	32	104	57	00
10	02	10	105	09	10
10	02	58	105	22	20

Thermometer 74° Fahrenheit.

CAMP AT MUSTANG SPRINGS.

DETERMINATION OF LATITUDE.

Determination of time, March 29, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	39	48	68	21	40
7	41	03	68	04	10
7	42	09	67	48	00
7	42	59	67	36	40
7	44	06	67	20	30
7	45	07	67	05	40
7	45	57	66	51	40
7	46	52	66	38	30

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	21	45	74	10	30
9	22	51	74	47	50
9	24	15	75	26	10
9	25	10	75	46	40
9	26	26	76	19	00
9	27	22	76	43	50
9	28	18	77	06	20
9	29	16	77	30	40

Thermometer 58° Fahrenheit.

Determination of latitude, March 29, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	39	48	68	21	40
7	41	03	68	04	10
7	42	09	67	48	00
7	42	59	67	36	40
7	44	06	67	20	30
7	45	07	67	05	40
7	45	57	66	51	40
7	46	52	66	38	30

Double altitudes of Capella, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	53	21	91	30	20
7	54	38	91	03	20
7	55	38	90	43	30
7	56	27	90	25	40
7	57	30	90	04	20
7	58	24	89	45	40
7	59	23	89	25	00
8	00	19	89	05	40

Thermometer 58° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, March 29, 1854.—*Double altitudes of a Geminorum (Castor,) in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	42	50	125	41	10
8	44	07	125	08	20
8	45	17	124	38	50
8	46	50	123	59	50
8	48	16	123	22	50
8	49	28	122	52	00
8	50	30	122	27	10
8	51	33	122	00	10

Double altitudes of a Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	08	31	114	05	50
8	10	41	114	30	20
8	11	46	114	41	40
8	12	56	114	54	00
8	17	59	115	22	40
8	19	05	115	33	20

Thermometer 58° Fahrenheit.

Determination of latitudes, March 29, 1854.—*Double allitudes of η Ursæ Majoris, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	26	46	79	19	00
8	28	10	79	46	00
8	29	20	80	07	40
8	30	25	80	30	00
8	31	25	80	48	30
8	32	29	81	10	00
8	33	35	81	29	10
8	34	35	81	49	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	21	45	74	10	30
9	22	51	74	47	50
9	24	15	75	26	10
9	25	10	75	46	40
9	26	26	76	19	00
9	27	22	76	43	50
9	28	18	77	06	20
9	29	16	77	30	40

Thermometer 58° Fahrenheit.

Observations for the variation of the compass, March 29, 1854.—*Double altitude of Sirius, in the west.*

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	39	48	68	21	40	S. 22	30	00	W.

Double altitude of Capella, in the west.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	53	21	91	30	20	N. 66	30	00	W.

Double altitude of η Ursæ Majoris, in the east.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
8	26	46	79	19	00	N. 37	50	00	E.

Double altitude of Arcturus, in the east.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
9	21	45	74	10	30	N. 76	45	00	E.

Determination of time, March 29, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	02	34	110	58	50
1	03	07	110	49	30
1	03	54	110	37	10
1	04	26	110	28	00
1	04	59	110	18	50
1	05	38	110	08	10
1	06	13	109	59	00
1	06	50	109	48	40
1	07	30	109	37	00
1	08	02	109	28	30

Thermometer 84° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of time, March 30, 1854.—*Double altitudes of the Sun's upper limb.*

Time, a m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	41	25	102	30	45
9	42	06	102	44	25
9	42	38	102	53	05
9	43	14	103	05	55
9	43	44	103	15	05
9	44	11	103	24	25
0	44	37	103	32	25
9	45	05	103	41	35

Thermometer 88° Fahrenheit.

AT BIG SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Determination of time, March 31, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	47	57	63	26	00
7	49	06	63	08	30
7	50	03	62	53	00
7	50	53	62	39	10
7	51	47	62	24	50
7	52	42	62	10	20
7	53	44	61	54	20
7	54	35	61	27	20 error.
7	55	51	61	06	50

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	38	04	67	33	10
9	39	01	67	51	20
9	40	01	68	09	20
9	40	57	68	26	10
9	41	51	68	43	10
9	42	46	69	00	00
9	43	44	69	17	00
9	44	31	69	32	30

Thermometer 41° Fahrenheit.

Determination of latitude, March 31, 1854.—*Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	21	17	63	48	40
7	25	44	63	44	20
7	30	19	63	41	50
7	34	56	63	38	40
7	39	38	63	35	50
7	43	46	63	32	30

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	47	57	63	26	00
7	49	06	63	08	30
7	50	03	62	53	00
7	50	53	62	39	10
7	51	47	62	24	50
7	52	42	62	10	20
7	53	44	61	54	20
7	54	35	61	27	20 error.
7	55	51	61	06	50

Thermometer 41° Fahrenheit.

Determination of latitude, March 31, 1854.—*Double altitudes of Capella, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	59	00	85	48	50
8	00	12	85	23	40
8	01	03	85	06	20
8	02	00	84	46	40
8	02	56	84	26	20
8	03	46	84	08	50
8	05	10	83	40	50
8	06	30	83	12	50

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	09	00	115	53	00
8	10	14	116	03	50
8	11	10	116	14	00
8	12	20	116	24	00
8	13	36	116	35	50
8	14	37	116	47	10
8	15	42	116	57	40
8	16	35	117	05	40

Thermometer 41° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, March 31, 1854.—*Double altitudes of η Ursæ Majoris, in the east.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	19	29	80	24	10
8	20	31	80	44	40
8	21	23	81	02	40
8	22	12	81	18	40
8	22	57	81	32	40
8	23	51	81	48	40
8	24	47	82	06	50
8	25	42	82	24	50

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	38	04	67	33	10
9	39	01	67	51	20
9	40	01	68	09	20
9	40	57	68	26	10
9	41	51	68	43	10
9	42	46	69	00	00
9	43	44	69	17	00
9	44	31	69	32	30

Thermometer 41° Fahrenheit.

Observations for the variation of the compass, March 31, 1854.—*Double altitude of Polaris, in the west.*

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	21	17	63	48	40	N. 13	30	00	W.

Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
7	47	57	63	26	00	S. 27	10	00	W.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.			
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*	
9	38	04	67	33	10	S. 59	00	00	

Determination of time, March 31, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	14	49	107	34	50
1	15	25	107	24	10
1	16	02	107	13	30
1	16	42	107	00	50
1	17	25	106	48	20
1	18	06	106	35	30
1	18	47	106	22	40
1	19	27	106	10	20

Thermometer 55½° Fahrenheit.

CAMP FORTY-FOUR MILES EAST OF SULPHUR SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time, 32° 30′.

Determination of time, April 14, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.			Chronometer slow of mean time.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
7	07	01	57	44	50			
7	08	19	57	32	40			
7	11	05	56	35	00			
7	12	03	56	18	00			
7	13	29	55	53	30			
7	14	29	55	37	00			
7	15	27	55	18	20			
7	16	18	55	03	40			
7	17	12	54	47	40			
7	18	23	54	26	10	0	32	17.09

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
8	04	06	70	33	20			
8	05	13	71	02	00			
8	06	07	71	24	40			
8	07	01	71	47	40			
8	08	10	72	16	30			
8	09	04	72	39	50			
8	09	57	73	02	00			
8	10	54	73	25	10			
8	11	51	73	50	20			
8	12	50	74	14	50	0	32	15.04

Thermometer 47° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, April 14, 1854.—*Double altitudes of Polaris, in the west.*

Time.			Altitudes.			Deduced latitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*
7	21	56	63	30	30			
7	24	30	63	28	30			
7	26	08	63	27	00			
7	27	59	63	25	50			
7	29	48	63	24	30	32	34	35.89
7	31	26	63	23	40			
7	33	13	63	22	50			
7	35	09	63	22	00			
7	37	07	63	20	50			
7	39	41	63	19	30	32	34	39.74
7	41	28	63	18	10			
7	43	41	68	17	00			
7	45	41	63	16	10			
7	47	38	63	14	50			
7	49	51	63	13	50	32	34	49.23
7	51	36	63	12	30			
7	53	40	63	11	20			
7	55	40	63	10	30			
7	58	00	63	09	00			
8	00	21	63	08	10			
8	02	08	63	07	10	32	34	44.22

Thermometer 47° Fahrenheit.

Determination of latitude, April 14, 1854.—*Double altitudes of Spica Virginis, in the east.*

Time.			Altitudes.			Deduced latitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*d.*	*m.*	*s.*
8	14	55	59	05	30			
8	16	09	59	29	50			
8	17	11	59	52	20			
8	18	08	60	09	50			
8	18	54	60	24	50	32	35	28
8	20	11	60	50	10			
8	21	05	61	07	50			
8	21	55	61	24	20			
8	22	45	61	40	20			
8	23	52	61	02	50	32	35	56
8	25	06	62	26	10			
8	26	16	62	49	50			
8	27	12	63	07	30			
8	28	35	63	33	40			
8	29	34	63	54	00	32	35	56
8	30	27	64	10	30			
8	31	53	64	38	00			
8	33	04	64	01	00			
8	33	58	65	17	20			
8	35	02	65	37	30			
8	36	22	66	02	10	32	35	45

Thermometer 47° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in the first computation of time, 32° 30′.

Determination of time, April 14, 1854.—*Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	07	01	57	44	50
7	08	19	57	32	40
7	11	05	56	35	00
7	12	03	56	18	00
7	13	29	55	53	30
7	14	29	55	37	00
7	15	27	55	18	20
7	16	18	55	03	40
7	17	12	54	47	40
7	18	23	54	26	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	04	06	70	33	20
8	05	13	71	02	00
8	06	07	71	24	40
8	07	01	71	47	40
8	08	10	72	16	30
8	09	04	72	39	50
8	09	57	73	02	00
8	10	54	73	25	10
8	11	51	73	50	20
8	12	50	74	14	50

Thermometer 47° Fahrenheit

MOST EASTERN TRIBUTARY OF THE COLORADO.

Determination of time, April 16, 1854.—*Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
1	09	20	114	28	20
1	10	23	114	06	30
1	11	02	113	53	20
1	11	38	113	41	00
1	12	10	113	30	40
1	12	39	113	19	50
1	13	22	113	05	30
1	13	55	112	54	00
1	14	26	112	43	10
1	15	10	112	28	10
1	15	48	112	15	10
1	16	26	112	02	10
1	17	04	111	48	30
1	17	39	111	36	50
1	18	10	111	25	40
1	18	43	111	14	40
1	19	11	111	04	00

Thermometer 80° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

CAMP ELEVEN AND FOUR-TENTHS MILES EAST OF THE SULPHUR SPRINGS OF THE COLORADO.

April 12, 1854.

	d.	m.	s.
Magnetic amplitude of the Sun's centre at his setting	00	00	00
Variation	9	58	50

CAMP ON DIVIDING RIDGE OF THE COLORADO AND BRAZOS RIVERS.

April 17, 1854.

	d.	m.	s.
Magnetic amplitude of the Sun's centre at his rising	N. 24	30	00

CAMP ON TRIBUTARY OF THE BRAZOS RIVER.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time, 32° 45′.

Determination of time, April 17, 1854.—*Double altitudes of Sirius, in the west.*

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	d. m. s.	h. m. s.
6 32 05	62 31 00	
6 33 11	62 12 40	
6 34 50	61 47 40	
6 35 48	61 32 10	
6 36 44	61 16 20	0 37 36.75
6 37 46	61 00 20	
6 38 41	60 45 50	
6 39 50	60 27 10	
6 40 52	60 10 10	
6 41 51	59 52 40	0 37 36.39

Double altitudes of Arcturus in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	d. m. s.	h. m. s.
7 54 05	73 32 20	
7 55 04	73 55 10	
7 56 07	74 22 40	
7 57 05	74 46 09	
7 58 20	75 18 50	0 37 30.28
7 59 17	75 42 00	
8 00 15	76 07 20	
8 01 11	76 32 00	
8 02 11	76 56 40	
8 03 21	77 24 50	0 37 30.60

Thermometer 64° Fahrenheit.

Determination of latitude, April 17, 1854.—*Double altitudes of Polaris, in the west.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	d. m. s.	d. m. s.
7 14 58	63 35 40	
7 17 04	63 34 20	
7 18 57	63 33 20	
7 21 43	63 32 00	
7 23 02	63 30 40	32 40 39.15
7 25 29	63 28 50	
7 27 46	63 27 40	
7 29 26	63 26 50	
7 30 59	63 25 40	
7 32 32	63 24 50	32 40 23.69
7 34 19	63 23 50	
7 36 00	63 22 50	
7 38 01	63 21 40	
7 39 49	63 20 50	
7 41 15	63 20 00	
7 42 44	63 19 30	32 40 23.91
7 44 29	63 18 30	
7 46 31	63 17 30	
7 48 10	63 16 20	
7 49 58	63 15 20	
7 51 42	63 14 10	32 40 24.41

Thermometer 64° Fahrenheit.

Determination of latitude, April 17, 1854.—*Double altitudes of Spica Virginis, in the east.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	d. m. s.	d. m. s.
8 35 26	70 45 10	
8 36 31	71 05 40	
8 37 30	71 22 40	
8 38 29	71 39 40	
8 39 26	71 56 10	32 42 51
8 40 23	72 11 20	
8 41 18	72 29 40	
8 42 09	72 42 30	
8 43 02	72 57 40	
8 43 57	73 13 10	
8 44 55	73 29 40	32 42 53.3
8 45 50	73 44 20	
8 46 44	73 59 50	
8 47 34	74 13 20	
8 48 34	74 32 10	
8 49 27	74 45 30	
8 50 15	74 58 10	32 42 40
8 51 10	75 12 40	
8 52 01	75 27 00	
8 52 59	75 42 10	
8 53 51	75 56 00	
8 54 44	76 10 00	32 42 55

Thermometer 64° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

AT CAMP ON TRIBUTARY OF THE BRAZOS, TEN MILES WEST OF THE CLEAR FORK.

DEDUCTION OF LATITUDE.

Approximate latitude to be used in the first computation of time, 32° 51′.

Determination of time, April 20, 1854.—*Double altitudes of Sirius, in the west.*

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
6 24 01	59 48 50	
6 25 46	59 19 40	
6 26 50	59 02 00	
6 27 39	58 48 30	
6 28 33	58 33 00	0 42 44.66
6 29 25	58 18 10	
6 30 18	58 04 20	
6 31 04	57 51 20	
6 31 55	57 37 30	
6 32 55	57 20 20	0 42 43.74

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
7 58 15	82 26 10	
7 59 13	82 49 00	
8 00 16	83 15 40	
8 01 15	83 38 40	
8 02 26	84 08 40	0 42 37.08
8 03 17	84 30 30	
8 04 05	84 52 10	
8 04 58	85 14 40	
8 06 11	85 43 10	
8 07 05	86 07 20	0 42 37.35

Thermometer 69° Fahrenheit.

Determination of latitude, April 20, 1854.—*Double altitudes of Polaris, in the west.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 14 26	63 52 20	
7 15 56	63 51 20	
7 17 37	63 50 20	
7 19 48	63 49 10	
7 22 01	63 48 10	32 53 46.38

Determination of latitude—Continued.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 23 52	63 47 00	
7 25 55	63 46 00	
7 28 25	63 44 40	
7 31 38	63 43 30	
7 34 43	63 41 40	32 53 54.28
7 36 30	63 40 10	
7 39 00	63 38 50	
7 41 27	63 37 40	
7 43 29	63 36 40	
7 45 24	63 35 30	
7 47 20	63 34 40	32 53 41.73
7 49 05	63 34 00	
7 50 52	63 33 00	
7 52 23	63 32 00	
7 54 26	63 31 00	
7 56 20	63 30 20	32 53 37.87

Thermometer 69° Fahrenheit.

Determination of latitude, April 20, 1854.—*Double altitudes of Spica Virginis, in the east.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
8 37 34	75 46 30	
8 38 47	76 06 20	
8 39 45	76 21 10	
8 40 32	76 33 20	
8 41 34	76 49 50	32 54 53
8 42 28	77 04 00	
8 43 19	77 16 50	
8 44 13	77 30 30	
8 46 02	77 58 40	
8 46 43	78 08 40	
8 47 27	78 20 40	32 54 48
8 48 15	78 31 50	
8 49 03	78 44 10	
8 49 53	78 55 20	
8 50 38	79 07 30	
8 51 39	79 22 20	
8 52 29	79 34 40	32 54 43
8 53 20	79 46 30	
8 54 03	79 57 10	
8 55 01	80 10 00	
8 55 52	80 23 10	
8 56 37	80 33 40	32 54 39

Thermometer 69° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Observations for the variation of the compass, April 20, 1854.—*Double altitudes of Polaris, in the west.*

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
7 36 30	63 40 10	N. 11 50 00 W.

Variation of compass, E. 10° 30′.

Double altitude of Spica Virginis, in the east.

Time, a. m.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
8 38 47	76 06 20	S. 49 20 40 E.

Variation of compass, E. 10° 30′ 50″.
Thermometer 69° Fahrenheit.

AT CLEAR FORK OF THE BRAZOS—CROSSING OF THE ROAD.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, 32° 55′.

Determination of time, April 24, 1854.—*Double altitudes of Procyon, in the west.*

Time.	Altitudes.
h. m. s.	*d. m. s.*
7 14 31	86 43 20 } error;
7 15 34	86 18 20 } rej'd.
7 17 37	85 32 30
7 18 37	85 10 50
7 19 27	84 51 40
7 20 07	84 36 10
7 20 51	84 19 00
7 21 39	84 01 40
7 22 25	83 43 20
7 23 16	83 24 50

Double altitudes of Arcturus, in the east.

Time.	Altitudes.
h. m. s.	*d. m. s.*
8 13 29	97 49 00
8 14 49	98 22 10
8 15 32	98 40 10
8 16 19	99 00 00
8 17 07	99 20 10
8 17 55	99 39 00
8 18 44	99 59 40
8 19 34	100 20 40
8 20 13	100 39 40
8 21 01	100 57 20

Thermometer 55° Fahrenheit.

Determination of latitude, April 24, 1854.—*Double altitudes of Polaris, in the west.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 26 40	63 45 40	
7 28 30	63 44 50	
7 30 28	63 43 50	
7 32 45	63 43 10	
7 34 56	63 42 00	32 59 18.5
7 36 55	63 41 00	
7 39 05	63 40 00	
7 41 30	63 38 50	
7 43 11	63 38 00	
7 46 16	63 36 40	
7 48 58	63 35 30	32 59 27.6
7 51 05	63 34 40	
7 53 51	53 33 40	
7 56 02	63 32 50	
7 58 10	63 32 00	
8 00 17	63 31 10	32 59 23.08
8 02 30	63 30 10	
8 04 50	63 29 10	
8 07 19	63 28 20	
8 09 55	63 27 20	
8 11 31	63 26 30	32 59 28.08

Thermometer 55° Fahrenheit.

Determination of latitude, April 24, 1854.—*Double altitudes of Spica Virginis, in the east.*

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
8 49 53	83 39 50	
8 50 45	83 50 20	
8 51 28	84 00 10	
8 52 07	84 08 10	
8 53 08	84 20 00	33 01 01
8 53 54	84 29 10	
8 54 42	84 39 00	
8 55 22	84 46 50	
8 56 08	84 56 20	
8 56 48	85 03 20	
8 57 27	85 11 10	33 00 47
8 58 07	85 18 40	
8 58 48	85 27 00	
8 59 36	85 35 30	
9 00 15	85 43 40	
9 00 58	85 51 40	
9 01 36	85 58 00	33 00 45
9 02 17	86 06 00	
9 03 03	86 14 20	
9 03 44	86 21 20	
9 04 23	86 28 10	
9 05 08	86 36 00	33 00 44

Thermometer 55° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Observations for the variation of the compass, April 24, 1854.—Double altitude of Polaris, in the west.

Time.	Altitude.	Magnetic bearing.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
7 32 45	63 43 10	N. 12 30 00 W.

Variation of compass, E. 11° 49′.

Double altitude of Spica Virginis, in the east.

Time.	Altitude.	Magnetic bearing.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
8 51 28	84 00 10	S. 40 00 00 E.

Variation of the compass, E. 10° 55′ 40″.
Thermometer 55° Fahrenheit.

AT CAMP ON WEST SIDE OF THE BRAZOS, OPPOSITE FORT BELKNAP.

DETERMINATION OF LATITUDE.

Determination of time, April 26, 1854.—Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	27	05	83	25	20
7	28	03	83	52	20
7	28	54	84	13	30
7	29	42	84	31	50
7	30	22	84	50	20
7	30	56	85	04	40
7	31	38	85	22	00
7	32	15	85	37	30
7	32	56	85	55	40
7	33	43	86	13	50

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	35	26	73	54	40
7	36	15	73	34	00
7	37	07	73	14	10
7	37	54	72	55	20
7	38	43	72	36	10
7	39	35	72	15	20
7	40	26	71	54	40
7	41	11	71	37	30
7	42	04	71	16	50
7	42	55	70	57	20

Thermometer 62° Fahrenheit.

Determination of latitude, April 26, 1854.—Double altitudes of a Ursæ Majoris, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	14	00	125	34	00
8	15	42	125	27	00
8	16	54	125	22	30
8	18	10	125	17	10
8	20	11	125	08	20
8	21	20	125	02	30
8	22	33	124	56	50
8	23	44	124	51	40
8	24	52	124	45	50
8	26	05	124	39	40
8	27	18	124	33	40
8	28	54	124	25	20
8	30	52	124	14	10
8	32	11	124	06	30
8	33	27	123	58	50
8	34	26	123	52	50
8	35	23	123	47	00
8	36	41	123	38	30
8	37	51	123	30	50
8	39	05	123	24	20
8	40	10	123	15	50

Thermometer 62° Fah. Clouds in the north obscured Polaris.

Determination of latitude, April 26, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	44	53	70	06	10
7	45	44	70	22	10
7	46	27	70	34	20
7	47	11	70	47	20
7	47	50	70	58	10
7	48	33	71	10	50
7	49	16	71	23	00
7	50	36	71	45	50
7	51	24	71	58	30
7	52	14	72	13	00
7	52	59	72	25	20
7	53	50	72	39	40
7	54	37	72	53	00
7	55	26	73	07	10
7	56	22	73	22	20
7	57	10	73	34	10
7	57	58	73	47	50
7	58	47	74	01	40
7	59	41	74	15	30
8	00	31	74	29	50
8	01	15	74	42	20
8	02	00	74	54	00

Thermometer 62° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Observations for variation of the compass, April 26, 1854.—Double altitude of Spica Virginis, in the east.

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
7 49 16	71 23 00	S. 53 30 00 E.

Thermometer 62° Fahrenheit.

CAMP FOUR MILES EAST OF THE WEST FORK OF THE TRINITY.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, 33° 10′.

Determination of time, April 28, 1854.—Double altitudes of Procyon, west.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
6 42 15	90 20 10	
6 43 28	89 53 10	
6 44 58	89 20 10	
6 45 50	89 02 20	
6 46 32	88 46 20	8 54 8.46
6 47 22	88 28 20	
6 48 10	88 10 20	
6 48 58	87 53 10	
6 49 47	87 34 00	
6 50 30	87 18 40	0 54 8.53

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
7 47 35	95 43 50	
7 48 41	96 10 40	
7 49 18	96 30 00	
7 50 19	96 51 40	
7 51 07	97 11 10	0 54 2.23
7 51 59	97 33 10	
7 52 57	97 57 00	
7 54 06	98 25 20	
7 55 11	98 53 20	
7 56 02	99 13 50	0 54 5.22

Thermometer 48° Fahrenheit.

Determination of latitude, April 28, 1854.—Double altitudes of Polaris, in the west.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 06 33	64 42 40	
7 09 57	64 40 50	
7 12 19	64 39 50	
7 13 42	64 39 10	
7 14 56	64 38 30	33 28 07.52
7 16 10	64 37 40	
7 18 00	64 36 50	
7 19 14	64 36 20	
7 20 58	64 35 50	
7 22 18	64 35 10	33 28 04.42
7 26 00	64 33 40	
7 28 07	64 33 00	
7 29 48	64 32 20	
7 31 05	64 31 40	
7 32 45	64 31 00	
7 34 25	64 30 10	33 28 16.57
7 37 47	64 28 30	
7 39 26	64 27 50	
7 41 08	64 27 10	
7 43 38	64 26 20	
7 45 44	64 25 40	33 27 59.01

Thermometer 48° Fahrenheit.

Determination of latitude, April 28, 1854.—Double altitudes of Spica Virginis, in the east.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 59 50	76 10 50	
8 00 45	76 24 40	
8 01 32	76 36 50	
8 02 22	76 50 10	
8 03 10	77 01 20	
8 03 59	77 12 40	33 30 05
8 04 45	77 24 40	
8 05 31	77 36 10	
8 06 17	77 47 10	
8 07 07	77 59 40	
8 07 50	78 09 50	33 30 11
8 08 29	78 19 50	
8 09 10	78 30 00	
8 09 55	78 39 50	
8 10 41	78 50 10	
8 11 24	79 01 10	
8 12 12	79 13 00	33 30 01
8 13 11	79 26 00	
8 13 58	79 36 30	
8 14 45	79 48 00	
8 15 34	79 59 00	
8 16 21	80 10 10	33 30 13

Thermometer 48° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Observations for the variation of the compass, April 28, 1854.—Double altitude of Polaris, in the west.

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
7 22 18	64 35 10	. 11 20 00 W.

Variation of compass, E. 10° 19′ 40″.

Double altitude of Spica Virginis, in the east.

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
8 00 45	76 24 40	S. 47 30 00 E.

Variation of compass, E. 10° 13′ 02″. Thermometer 48° Fahrenheit.

NOTE.—Continuous rain from the night of the 29th of April to the morning of the 6th of May, 1854.

CAMP ON THE WATERS OF THE TRINITY.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Approximate latitude to be used in first computation of time, 33° 31′ 35″.

Determination of time, May 6, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
2 17 27	85 44 55	
2 19 52	84 44 55	
2 22 24	83 42 55	
2 23 15	83 21 45	
2 23 42	83 09 55	
2 24 17	82 55 25	
2 24 47	82 43 15	
2 25 25	82 27 45	
2 25 59	82 13 35	
2 26 30	82 00 25	
2 27 08	81 45 25	
2 27 37	81 33 25	0 56 54.79

Thermometer 78° Fahrenheit.

Determination of longitude by lunar distances, May 6, 1854.—The Moon's western limb and nearest limb of the Sun, west.

Time, p. m.	Angular distances.	Deduced longitude, (in arc.)
h. m. s.	*d. m. s.*	*h. m. s.*
2 33 08	107 27 25	
2 34 50	107 28 15	
2 36 04	107 29 05	6 34 43
Lost.	Clouds.	

Double altitude of the Moon's bright (upper) limb, in the east.

Time.	Altitude.
h. m. s.	*d. m. s.*
2 45 44	69 57 15

Double altitude of the Sun's upper limb, in the west.

Time.	Altitude.
h. m. s.	*d. m. s.*
2 47 29	73 18 25

Time, p. m.	Angular distances.	Deduced longitude.
h. m. s.	*d. m. s.*	*h. m. s.*
2 48 59	107 33 55	
2 50 10	107 34 25	
2 51 41	107 34 55	
2 53 04	107 35 25	6 35 17

Double altitude of the Sun's upper limb, in the west.

Time.	Altitude.
h. m. s.	*d. m. s.*
2 54 39	70 19 25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.	Altitude.
h. m. s.	*d. m. s.*
2 57 41	74 46 15

ASTRONOMICAL OBSERVATIONS—Continued.

Time, p. m.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
2 59 20	107 36 35	
3 01 38	107 37 25	
3 03 42	107 33 25	
3 05 39	107 39 35	6 33 28

Double altitude of the Moon's bright (upper) limb, in the east.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
3 45 12	93 39 25

Thermometer 66° Fahrenheit.

Second series.—The Moon's western limb and nearest limb of the Sun, west.

Time, p. m.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
3 21 15	107 44 45	
3 23 05	107 45 55	
3 27 29	107 47 35	
3 29 10	107 48 15	6 35 08

Double altitude of the Moon's bright (upper) limb, in the east.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
3 31 19	88 11 35

Double altitude of the Sun's upper limb, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
3 32 37	54 32 05

Time, p. m.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
3 35 35	107 50 25	
3 37 25	107 51 05	
3 40 43	107 52 15	
3 42 18	107 52 45	6 34 55

Double altitude of the Sun's upper limb, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
3 43 24	50 03 35

Time, p. m.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
3 46 30	107 53 45	
3 48 15	107 54 15	
3 49 44	107 54 45	
3 51 15	107 55 15	6 35 10

Thermometer 66° Fahrenheit.

Determination of time, May 6, 1854.—Double altitudes of Procyon, in the west.

Time.	Altitudes.	Chronometer slow of mean time.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
6 43 05	77 05 10	
6 44 19	76 36 40	
6 45 32	76 07 10	
6 46 24	75 47 50	
6 47 16	75 26 50	0 56 59.75
6 48 12	75 05 20	
6 49 02	74 46 40	
6 49 55	74 25 10	
6 50 51	74 03 10	
6 51 43	73 42 40	0 56 59.85

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
6 53 26	87 32 40	
6 54 15	87 52 20	
6 55 05	88 12 50	
6 55 48	88 31 00	
6 56 28	88 48 10	0 56 56.33
6 57 12	89 05 40	
6 58 26	89 36 50	
6 59 14	89 57 00	
6 59 54	90 14 20	
7 00 36	90 31 20	0 56 57.33

Thermometer 66° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of longitude by lunar distances, May 6, 1854.—*The Moon's western limb and Pollux, west.*

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	47	23	44	16	20
7	51	19	44	18	10
7	53	20	44	19	00
7	55	17	44	19	40

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	57	30	128	37	20

Double altitude of Pollux, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	00	31	70	01	20

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	03	54	44	22	40
8	09	30	44	24	40
8	11	02	44	25	20
8	12	30	44	26	00

Double altitude of Pollux, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	15	24	64	00	10

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	18	13	122	06	10

Time.			Angular distances.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	19	55	44	29	30
8	21	43	44	30	10
8	23	30	44	31	00
8	25	20	44	31	50

Thermometer 66° Fahrenheit.

Determination of longitude by lunar distances, May 6, 1854.—*The Moon's western limb and Spica Virginis, east.*

Time.			Angular distances.			Deduced longitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
8	33	26	46	15	10			
8	35	23	46	14	40			
8	36	57	46	14	00			
8	38	55	46	23	10	6	34	41

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	40	31	114	21	10

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	45	42	90	28	40

Time.			Angular distances.			Deduced longitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*	*h.*	*m.*	*s.*
8	50	12	46	08	20			
8	53	19	46	07	00			
8	55	29	46	06	10			
8	57	32	46	05	20	6	35	52

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
9	01	05	91	36	00

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of the Moon's upper limb, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
9 03 02	106 00 00

Time.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
9 07 31	46 01 40	
9 09 34	46 01 00	
9 11 22	46 00 20	
9 13 29	45 59 30	6 35 23

Thermometer 66° Fahrenheit.

Second series.—The Moon's western limb and Spica Virginis, east.

Time.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
9 56 13	45 42 40	
9 58 03	45 42 00	
9 59 32	45 41 20	
10 00 44	45 40 30	6 33 57

Double altitude of the Moon's upper limb, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
10 02 52	82 30 30

Double altitude of Spica Virginis, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
10 04 28	89 50 40

Time.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
10 05 48	45 38 50	
10 07 11	45 38 00	
10 08 57	45 37 00	
10 10 24	45 36 20	6 33 54

Double altitude of Spica Virginis, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
10 11 47	89 00 10

Double altitude of the Moon's upper limb, in the west.

Time.	Altitude.
h. *m.* *s.*	*d.* *m.* *s.*
10 13 29	78 12 10

Time.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
10 15 12	45 34 50	
10 16 38	45 34 00	
10 17 59	45 33 10	
10 19 45	45 32 20	6 33 50

Thermometer 66° Fahrenheit.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time, 33° 31′ 35″.

Determination of time, April 29, 1854.—Double altitudes of Procyon, in the west.

Time.	Altitudes.	Chronometer slow of mean time.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
6 39 14	89 04 30	
6 40 44	88 31 40	
6 41 34	88 14 10	
6 42 30	87 53 40	
6 43 26	87 32 20	0 56 17.71
6 44 19	87 13 40	
6 45 07	86 54 10	
9 45 54	86 37 50	
6 46 46	86 19 20	
6 47 34	86 01 40	0 56 18.82

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
7 24 39	88 47 40	
7 25 47	89 16 30	
7 26 40	89 38 50	
7 27 34	90 00 50	
7 28 21	90 21 40	0 56 17.27
7 29 04	90 38 40	
7 29 50	90 57 50	
7 30 46	91 21 20	
7 31 36	91 41 50	
7 32 23	92 01 40	0 56 17.57

Thermometer 54° Fahrenheit.

Determination of latitude, April 29, 1854.—Double altitudes of Polaris, in the west.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
7 35 22	64 32 50	
7 37 21	64 32 10	
7 39 31	64 31 20	
7 41 47	64 30 10	
7 43 55	64 29 20	33 31 07.8
7 48 40	64 28 10	
7 50 41	64 27 30	
7 53 54	64 26 40	
7 56 22	64 25 50	
8 00 20	64 24 40	33 31 22.1
8 03 22	64 23 50	
8 05 27	64 22 40	
8 07 45	64 22 00	
8 10 03	64 21 00	
8 12 58	64 20 10	
8 15 38	64 19 30	33 31 11.3
8 17 34	64 19 00	
8 19 55	64 18 30	
8 21 59	64 18 00	
8 23 56	64 17 20	
8 25 54	64 16 40	33 31 04.5

Thermometer 54° Fahrenheit.

Determination of latitude, April 29, 1854.—Double altitudes of Spica Virginis, in the east.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
8 28 10	83 52 10	
8 29 17	84 04 20	
8 30 55	84 23 40	
8 31 38	84 32 10	
8 32 23	84 40 50	33 33 09

Determination of latitude—Continued.

Time.	Altitudes.	Deduced latitudes.
h. m. s.	*d. m. s.*	*d. m. s.*
8 33 06	84 48 50	
8 33 48	84 56 00	
8 34 34	85 04 50	
8 35 19	85 12 30	
8 36 05	85 20 10	
8 36 56	85 30 00	33 32 54.4
8 37 45	85 38 30	
8 38 40	85 47 50	
8 39 29	85 56 50	
8 40 18	86 05 20	
8 40 59	86 12 20	
8 41 48	86 20 40	
8 42 25	86 26 00	
8 43 15	86 33 30	
8 43 59	86 42 00	
8 44 48	86 49 00	
8 45 33	86 55 40	33 32 47

Thermometer 54° Fahrenheit.

Determination of latitude, May 6, 1854.—Double altitudes of Polaris, in the east.

Time.	Altitudes.	Deduced latitude.
h. m. s.	*d. m. s.*	*d. m. s.*
10 22 08	64 18 50	
10 24 46	64 19 20	
10 28 29	64 20 10	
10 32 13	64 21 20	
10 34 16	64 22 10	
10 36 16	64 23 00	
10 38 34	64 23 50	
10 40 19	64 24 30	
10 42 23	64 25 10	
10 45 08	64 26 00	
10 47 04	64 26 40	
10 49 43	64 27 10	
10 51 51	64 27 50	
10 53 56	64 28 40	
10 55 57	64 29 20	
10 57 35	64 30 00	
10 59 34	64 30 50	
11 01 40	64 31 30	
11 03 38	64 32 20	
11 05 18	64 33 40	
11 07 25	64 34 20	33 31 58

Observations for the variation of the compass, May 6, 1854.—Double altitude of Polaris, in the east.

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
10 24 46	64 19 20	N. 9 50 00 W.

Variation of compass, E. 10° 36′ 40″.

ASTRONOMICAL OBSERVATIONS—Continued.

Double altitude of Spica Virginis, in the east.

Time.	Altitude.	Magnetic bearing.
h. m. s.	*d. m. s.*	*d. m. s.*
7 21 03	74 59 30	S. 49 00 00 E.

Variation of compass, E. 10° 19′ 12″. Thermometer 66° Fah.

ON ELM FORK OF TRINITY RIVER.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Approximate latitude to be used in first computation of time, 33° 45′.

Determination of time, May 10, 1854.—*Double altitudes of Pollux, in the west.*

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
6 38 24	94 44 25	1 3 15.4
6 39 33	94 17 05	1 3 12.3
6 40 22	93 56 55	1 3 12.4
6 41 18	93 34 15	1 3 16.5
6 42 13	93 10 05	1 3 14.5
6 43 05	92 48 25	1 3 13.5
6 43 57	92 27 45	1 3 12.0
6 44 55	92 03 05	1 3 13.8
6 45 40	91 44 15	1 3 13.0
6 46 33	91 22 55	

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. m. s.	*d. m. s.*	*h. m. s.*
6 48 23	94 32 45	1 3 14.3
6 49 22	94 57 05	1 3 13.8
6 50 27	95 25 55	1 3 16.4
6 51 13	95 43 05	1 3 14.6
6 51 57	96 01 05	1 3 13.8
6 52 53	96 24 35	1 3 14.6
6 53 47	96 47 35	1 3 16.4
6 54 34	97 06 05	1 3 14.4
6 55 17	97 24 25	1 3 15.6
6 56 13	97 47 05	1 3 14.6

Thermometer 56° Fahrenheit.

Determination of longitude by lunar distances.—The Moon's western limb and Pollux, west.

Time.	Angular distances.	Deduced longitude.
h. m. s.	*d. m. s.*	*h. m. s.*
7 00 31	98 06 15	
7 03 19	98 07 35	
7 05 18	98 08 35	
7 07 03	98 09 25	6 29 07

Double altitude of the Moon's upper limb, in the east.

Time.	Altitude.
h. m. s.	*d. m. s.*
7 08 49	69 20 55

Double altitude of Pollux, in the west.

Time.	Altitude.
h. m. s.	*d. m. s.*
7 11 30	81 03 15

Time.	Angular distances.	Deduced longitude.
h. m. s.	*d. m. s.*	*h. m. s.*
7 13 17	98 11 45	
7 15 00	98 12 55	
7 16 55	98 14 05	
7 18 59	98 15 05	6 29 08

Double altitude of Pollux, in the west.

Time.	Altitude.
h. m. s.	*d. m. s.*
7 22 07	76 46 55

Double altitude of the Moon's upper limb, in the east.

Time.	Altitude.
h. m. s.	*d. m. s.*
7 23 38	73 27 35

ASTRONOMICAL OBSERVATIONS—Continued.

Time.	Angular distances.	Deduced longitude.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
7 26 10	98 18 35	
7 27 57	98 19 35	
7 29 45	98 20 15	
7 31 21	98 20 55	6 30 18.5

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, 33° 45′.

Determination of time, May 10, 1854.—*Double altitudes of Pollux, in the west.*

Time.	Altitudes.	Chronometer slow of mean time.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
6 38 24	94 44 25	1 3 15.3
6 39 33	94 17 05	1 3 12.3
6 40 22	93 56 55	1 3 12.4
6 41 18	93 34 15	1 3 16.5
6 42 13	93 10 05	1 3 14.5
6 43 05	92 48 35	1 3 13.4
6 43 57	92 27 45	1 3 12.5
6 44 55	92 03 05	1 3 13.8
6 45 40	91 44 15	1 3 12.8
6 46 33	91 22 55	1 3 11.8

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
h. *m.* *s.*	*d.* *m.* *s.*	*h.* *m.* *s.*
6 48 23	94 32 45	1 3 14.3
6 49 22	94 57 05	1 3 13.8
6 50 27	95 25 55	1 3 16.4
6 51 13	95 43 05	1 3 14.6
6 51 57	96 01 05	1 3 13.8
6 52 53	96 24 35	1 3 14.6
6 53 47	96 47 35	1 3 16.7
6 54 34	97 06 05	1 3 14.4
6 55 17	97 24 25	1 3 15.6
6 56 13	97 47 05	1 3 14.6

Thermometer 56° Fahrenheit.

Determination of latitude, May 10, 1854.—*Double altitudes of Regulus, in the west.*

Time.	Altitudes.	Deduced latitude.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
8 00 51	104 37 25	
8 02 02	104 12 15	
8 03 08	103 47 15	
8 04 03	103 25 25	
8 04 49	103 09 05	
8 05 35	102 51 25	
8 06 33	102 29 15	
8 07 28	102 08 25	
8 08 33	101 44 25	
8 09 18	101 26 25	33 41 40

Double altitudes of Polaris, in the east.

Time.	Altitudes.	Deduced latitude.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
8 15 27	64 28 55	
8 17 00	64 29 45	
8 18 41	64 30 45	
8 20 31	64 31 25	
8 23 47	64 29 15	
8 26 38	64 29 55	
8 28 25	64 30 25	33 41 42

Stars very dim.

Thermometer 56° Fahrenheit.

Observations for the variation of the compass, May 10, 1854.—*Double altitude of Polaris in the east.*

Time.	Altitude.	Magnetic bearing.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
8 23 47	64 29 15	N. 10 50 00 W.

Variation of compass, E. 10° 36′ 00″.

CAMP FOUR MILES EAST OF THE LOWER CROSS TIMBERS.

DETERMINATION OF LATITUDE.

Determination of time, May 13, 1854.—*Double altitudes of Pollux, in the west.*

Time.	Altitudes.
h. *m.* *s.*	*d.* *m.* *s.*
6 48 02	84 26 25 dbtfl.
6 48 59	84 07 15
6 50 12	83 48 05
6 51 00	83 18 15
6 51 47	82 58 15
6 52 42	82 35 45
6 53 42	82 12 25
6 56 40	80 58 55
6 57 30	80 37 15
6 58 25	80 16 15

Double altitudes of Arcturus, in the east.

Time.	Altitudes.
h. *m.* *s.*	*d.* *m.* *s.*
6 38 57	96 55 25
6 39 51	97 16 35
6 40 36	97 35 05
6 41 21	97 51 55
6 42 04	98 12 55
6 42 46	98 29 15
6 43 24	98 44 25
6 44 06	99 01 15
6 44 43	99 16 25
6 45 23	99 34 05

Thermometer 58° Fahrenheit.

ASTRONOMICAL OBSERVATIONS—Continued.

Determination of latitude, May, 13, 1854.—Double altitudes of Polaris, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
8	11	07	64	33	15
8	12	52	64	33	55
Observations suspended; night wet and misty.					
8	53	56	64	33	05
8	56	20	64	34	35
9	05	10	64	33	55

Observations discontinued; night wet and misty.

Thermometer 58° Fahrenheit.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
7	11	40	81	18	25
7	12	35	81	29	25
7	13	19	81	33	35
7	14	13	81	50	35
7	15	10	82	02	35
7	16	03	82	12	55
7	17	07	82	26	35
7	18	00	82	37	15
7	19	02	82	47	55
7	20	03	83	01	25
7	21	22	83	17	35
7	22	35	83	31	25
7	23	37	83	43	55
7	24	52	83	57	35
7	25	42	84	06	25
7	26	25	84	15	05
7	27	05	84	23	25
7	27	50	84	31	25
7	28	38	84	39	45
7	29	18	84	47	25
7	30	06	84	55	25
7	31	04	85	05	35

Thermometer 58° Fahrenheit.

Determination of time, May 13, 1854.—Double altitudes of Pollux, in the west.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	48	02	84	26	25
6	48	59	84	07	15
6	50	12	83	48	05
6	51	00	83	18	15

Determination of time—Continued.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	51	47	82	58	15
6	52	42	82	35	45
6	53	42	82	12	25
6	56	40	80	58	55
6	57	30	80	37	15
6	58	25	80	16	15

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
h.	*m.*	*s.*	*d.*	*m.*	*s.*
6	38	57	96	55	25
6	39	51	97	16	35
6	40	36	97	35	05
6	41	21	97	51	55
6	42	04	98	12	55
6	42	46	98	29	15
6	43	24	98	44	25
6	44	06	99	01	15
6	44	43	99	16	25
6	45	23	99	34	05

Thermometer 58° Fahrenheit.

Observations for the variation of the compass, May 13, 1854.—Double altitude of Polaris, in the west.

Time.	Altitude.	Magnetic bearing.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
8 12 52	64 33 55	N. 10 55 00 W.

Double altitude of Spica Virginis, in the east.

Time.	Altitude.	Magnetic bearing.
h. *m.* *s.*	*d.* *m.* *s.*	*d.* *m.* *s.*
7 19 02	82 47 55	S. 39 30 00 E.

Thermometer 58° Fahrenheit.

REPORT

ON THE

BOTANY OF THE EXPEDITION:

BY

JOHN TORREY AND ASA GRAY.

ROUTE NEAR THE THIRTY-SECOND PARALLEL OF NORTH LATITUDE, UNDER THE COMMAND OF BREVET CAPTAIN JOHN POPE, CORPS OF TOPOGRAPHICAL ENGINEERS.

BOTANICAL REPORT.

Catalogue of Plants collected on the Expedition. By JOHN TORREY *and* ASA GRAY.

RANUNCULACEÆ.

CLEMATIS DRUMMONDII, *Torr. and Gray, Fl.* 1, *p.* 9. On the upper Colorado, Texas; April.

ANEMONE CAROLINIANA, *Walt.*; *Torr. and Gray, Fl.* 1, *p.* 12; *Torr. in Marcy's Rep. t.* 1. Delaware creek to the Sacramento, the Pecos, and the Colorado; March, April.

MYOSURUS MINIMUS, *Linn.* Head of the Colorado; April.

DELPHINIUM AZUREUM, *Michx. Fl.* 1, *p.* 314. Western Texas; April. Broad-leaved varieties.

BERBERIDACEÆ.

BERBERIS TRIFOLIOLATA, *Moricand; Gray, Pl. Lindh.* 2, *p.* 142. Base of the Guadalupe mountains, New Mexico; March.

PAPAVERACEÆ & FUMARIACEÆ.

ARGEMONE MEXICANA, *Linn.* Western Texas; April.

CORYDALIS AUREA, *Willd.* Delaware creek to the Sacramento and Pecos; March.

CRUCIFERÆ.

STREPTANTHUS PETIOLARIS, *Gray, Pl. Fendl. p.* 7. On the upper Colorado, Texas.

STREPTANTHUS CARINATUS, *Wright in Gray, Pl. Wright*, 2, *p.* 11. Rocky hills on the Pecos, New Mexico; March. Smaller specimens than Wright's, and, like those, in flower only.

GREGGIA CAMPORUM, *Gray, Pl. Wright*, 1, *p.* 9, *t.* 1. On the Pecos, &c.; March. In flower only.

SISYMBRIUM CANESCENS, *Nutt.* Delaware creek to the Colorado; March, April.

ERYSIMUM ASPERUM, *DC.; Torr. and Gray, Fl.* 1, *p.* 95. On the Pecos, Llano Estacado, and upper Colorado; March, April.

DITTHYRÆA WISLIZENI, *Engelm. in Wisl. N. Mex. p.* 11; *Torr. in Marcy's Rep. t.* 2. On the Pecos, Llano Estacado, &c.

VESICARIA GRACILIS, *Hook. Bot. Mag. t.* 3533; *Gray, Pl. Lindh.* 2, *p.* 148. On the Pecos, Llano Estacado, and upper Colorado; March, April. Except by its non-stipitate silicles, V. angustifolia, *Nutt.*, is apparently undistinguishable from V. gracilis; and there is some reason to fear that this difference is not constant.

VESICARIA GORDONI, *Gray, l. c., p.* 149. Llano Estacado; April. There is reason to fear that this also passes into the foregoing.

VESICARIA ARGYRÆA, *Gray, Pl. Lindh.* 2, *p.* 146. Between Delaware creek and the Pecos; March. Not yet in flower.

Vesicaria Fendleri, *Gray, Pl. Fendl. p.* 9; V. stenophylla, *Gray, Pl. Lindh.* 2, *p.* 149. Everywhere on Delaware creek, the Pecos, Llano Estacado, &c.; March, April. To this, it is now evident, belongs the V. stenophylla; and the species exhibits great diversities in its mode of growth and foliage, as also in the size and even the shape of its pods. The name V. Fendleri is the older one; that of V. stenophylla is applicable only to some of the forms which the species assumes.

Vesicaria Ludoviciana, *DC. Syst.* 2, *p.* 297. On the Pecos; March. Not in flower.

Draba cuneifolia, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 108. Delaware creek to the Colorado.

Selenia dissecta, (n. sp., Plate I.) Leaves bipinnately divided, the segments linear; style not longer than the ovary; valves of the pod imperfectly one-nerved; seeds on short and thick funiculi.—In sandy or gravelly soil, from Delaware springs to the Llano Estacado; March and April. In flower, and with some mature fruit. This second species of Nuttall's genus Selenia is perhaps the most interesting plant of the present collection. It is a sort of biennial, (like so many of this region,) the plant having grown from the seed the preceding autumn, and begun to flower early in the following spring. The earliest flowers, borne on slender peduncles, spring directly from the crown, among the tufted radical leaves. Later, an ascending and sparsely leafy stem rises to the height of from three to six inches, and bears a raceme of leafy-bracted flowers, in the manner of L. aurea. The blossoms appear to be considerably larger than in that species, at least the earlier ones, the petals being fully half an inch long; but their form, and apparently their color, is the same. The leaves are all pinnately divided, with their primary divisions pinnately 3–9-parted. The anthers are linear, rather than oblong. The style, although slender, is hardly as long as the ovary: stigma rather large, depressed. The silicle is elliptical, slightly inclined to obovate, very flat, seven to eight lines long, scarcely stipitate, rounded at the summit, and abruptly tipped with the comparatively short style; valves minutely reticulate-veiny; a mid-nerve is usually evident from the base to the middle, or sometimes even to the summit. Septum complete in the specimens examined, obscurely two-nerved in the middle; the areolæ large, and nearly as in L. aurea. The seeds resemble those of that species, but are borne on short and thick funiculi, the base of which is somewhat adnate to the margin of the septum; and the cœcal pouch at the hilum is small, or indistinct. Cotyledons orbicular, accumbent against the ascending radicle, which is on the side remote from the placenta. As already shown, (*in Gen. Ill.* 1, *p.* 158,) the genus belongs to the Alysseæ.

Lepidum Alyssoides, *Gray, Pl. Fendl. p.* 10. Llano Estacado; April.

Lepidum Wrightii, *Gray, Pl. Wright.* 2, *p.* 15. On the Pecos, Colorado, &c.

Lepidum intermedium, *Gray, l. c.* Near Fort Washita; April.

CISTACEÆ.

Lechea minor, *Lam.; Torr. and Gray, Fl.* 1, *p.* 153. On the Llano Estacado; March. Without flowers or fruit.

CARYOPHYLLACEÆ.

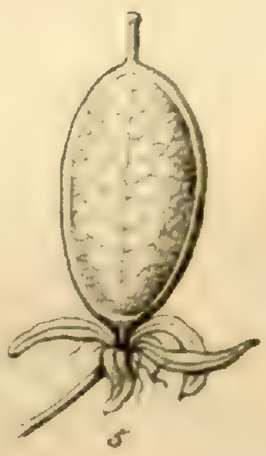
Silene Antirrhina, *Linn.* On the upper Colorado, Texas; April.

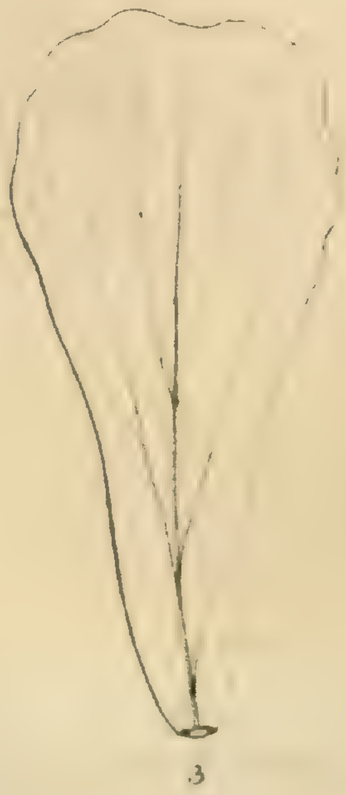
Paronychia Jamesii, *Torr. and Gray, Fl.* 1, *p.* 170. Guadalupe mountains, New Mexico. Without flowers.

MALVACEÆ.

Callirrhöe digitata, *Nutt.; Gray, Pl. Fendl. p.* 17. On the upper Colorado, Texas; April.

Callirrhöe involucrata, *Gray, l. c.* A small variety. On the upper Colorado; April.





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SELENIA DISSECTA

Prague del.

P.S.Duval & Co. Lith. Philad.a

Prague

MALVALTRUM COCCINEUM, *Gray, Pl. Fendl. p.* 21. Everywhere between the Rio Grande and the Colorado; March, April.

SPHÆRALCEA HASTULATA, *Gray, Pl. Wright.* 1, *p.* 17. On the Pecos and Colorado.

SPHÆRALCEA ANGUSTIFOLIA, *Spach;* the small flowered variety, S. stellata, *Torr.* Pecos to Llano Estacado; March.

SPHÆRALCEA FENDLERI, *Gray, Pl. Wright.* 1, *p.* 21. Cotton-wood Springs, New Mexico. Fruit only, without foliage.

GERANIACEÆ.

GERANIUM CAROLINIANUM, *Linn.* From Llano Estacado to Colorado, &c.

ERODIUM TEXANUM, *Gray, Pl. Lindh.* 2, *p.* 157; *and Gen. Ill. t.* 151. From the Pecos to the Colorado; March and April.

OXALIDACEÆ.

OXALIS WRIGHTII, *Gray, Pl. Wright.* 1, *p.* 27. On the Pecos; March.

LINACEÆ.

LINUM RIGIDUM, *Pursh, Fl.* 1, *p.* 210. On the Pecos, Llano Estacado, and upper Colorado; March, April.

LINUM MULTICAULE, *Hook. in Torr. and Gray, Fl.* 1, *p.* 678. Llano Estacado; April; Mr. Garrard.

LINUM PERENNE, *Linn.* From New Mexico to the Colorado; March, April.

ZYGOPHYLLACEÆ.

LARREA MEXICANA, *Moricand; Torr. in Emory's Rep. p.* 137, *t.* 3. From the Rio Grande to Llano Estacado, &c. Not yet in flower.

RUTACEÆ.

ZANTHOXYLUM CAROLINIANUM, *Lam.; Torr. and Gray, Fl.* 1, *p.* 214. Western Texas; April. The variety characterized in *Pl. Wright. t. p.* 31.

RUTOSMA TEXANUM, *Gray, Gen. Ill.* 2, *p.* 144, *t.* 155? On the Pecos, &c.; March.

*** Captain Pope collected, on the Organ mountains, specimens, without flowers or fruit, of a remarkable Rutaceous plant, which had been previously gathered there by Mr. Wright, and afterwards by H. B. Gray, Esq. We have also received it from Dr. Edwards, of the United States army, who found it on the Mimbres. Dr. J. M. Bigelow and Mr. Schott were so fortunate as to detect it in fruit, while they were engaged in the Mexican boundary survey, under the command of Major W. H. Emory. The former gentleman collected it, in 1852, on the Florence mountains, which, we believe, are in the southern part of New Mexico, near the Rio Grande; and Mr. Schott obtained it farther down the river. For want of the flowers, a complete description of the plant cannot be given; but there are sufficient materials to show that it is quite a distinct genus, of which a full account will be given in Dr. Torrey's botany of the Mexican boundary survey, under the name of ASTROPHYLLUM DUMOSUM. The plant is a low, much branched shrub, with opposite, palmately 7–10-foliolate, petiolate leaves; the leaflets narrowly linear, coriaceous, marked (as are the petioles and younger branches) with large and prominent glands. These glands on the leaflets are somewhat distant, and form a row along each margin. They are filled with a strong-smelling, acrid, volatile oil. The flowers are hermaphrodite, solitary, on long pedicels, which are lateral and terminal. On one of the specimens was a flower-bud, and on the other specimens were several pedicels supporting unfructified ovaries, besides abundance of ripe fruit. The bud contained ten stamens in two series, with subu-

late filaments from a broad base, and oblong 2-celled anthers. Opposite the shorter or interior stamens, (and alternating with the exterior ones,) were five ovate scales or petals. The characters of the calyx were not satisfactorily determined. There was no disk perceptible in the bud, and it is very inconspicuous in the flowers that had not matured their fruit. There are five one-celled oblong ovaries, which slightly cohere towards the base, each produced into a short incurved beak or horn. The styles are distinct, and arise from near the middle of the carpels on the inside; but the stigmas are united into an oblong 5-grooved head. Ovules two in each cell, collateral, inserted at the origin of the style. Only two of the carpels ripen. They are sessile, slightly united at the base, broadly ovate, compressed, dotted with small brown glands, and mucronate with the persistent base of the style; but the beak, which in the ovary was at the summit of the cell, has now become a dorsal tooth. At an early period the capsule opens nearly the whole length of the ventral suture, and down the back as far as the tooth. The endocarp also separates almost entirely from the epicarp. The seeds are usually solitary in each cell. They are ovate-globose, black and shining. The embryo is broadly oval, slightly curved, flattish, with a very short radicle; and there is little or no albumen.

ANACARDIACEÆ.

RHUS GLABRA, *Linn.* Near Fort Washita; April.

RHUS TRILOBATA, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 219. On the upper Colorado, Texas; April.

RHUS MICROPHYLLA, *Engelm. in Pl. Wright.* 1, *p.* 31. With the preceding species.

VITACEÆ.

VITIA RUPESTRIS, *Scheele, in Linnæa*, 21, *p.* 591. Western Texas; April 21. In flower.

RHAMNACEÆ.

CEANOTHUS OVATUS, *Desf.* (C. ovalis, *Bigelow.*) Near Fort Chadbourne; also a downy variety on the Colorado, Texas.

ZIZYPHUS LYCIODES, *Gray, Pl. Lindh.* 2, *p.* 168. Western Texas; April.

MICRORHAMNUS ERICOIDES, *Gray, Pl. Wrighl.* 1, *p.* 34. Near Delaware Springs, &c.; March.

SAPINDACEÆ.

SAPINDUS MARGINATUS, *Willd.; Gay, Gen. Ill.* 2, *t.* 180. Pecos and Llano Estacado. Called *Wild China* in Texas and Arkansas.

UNGNADIA SPECIOSA, *Endl.; Gray, Gen. Ill.* 2, *t.* 178, 179. Big Springs of the Colorado and elsewhere; April.

POLYGALACEÆ.

POLYGALA ALBA, *Nutt. Gen.* 2, *p.* 87. Llano Estacado, Colorado, &c.

POLYGALA MACRADENIA, *Gray, Pl. Wright.* 1, *p.* 38. On the Pecos; March.

KRAMERIA LANCEOLATA, *Torr.; Gray, Gen. Ill. t.* 187, 188. Western Texas; April.

LEGUMINOSÆ.

VICIA LEAVENWORTHII, *Torr. and Gray, Fl.* 1, *p.* 271. On the upper Colorado, Texas; April.

VICIA EXIGUA, *Nutt. in Torr. and Gray, l. c.; Gray, Pl. Wright.* 2, *p.* 32. Llano Estacado; March, April.

TEPHROSIA VIRGINIANA, *Pers. Syn.* 2, *p.* 328. Western Texas; May.

AMORPHA FRUTICOSA, *Linn. var.* On the upper Colorado; April.

PSORALEA ESCULENTA, *Pursh, Fl.* 2, *p.* 475, *t.* 22. On the Colorado, Western Texas; April.

PSORALEA OBTUSILOBA, *Torr. and Gray, Fl.* 1, *p.* 300. Western Texas; May.

PSORALEA FLORIBUNDA, *Nutt. in Torr. and Gray, Fl. l. c.* Western Texas; May.

PSORALEA CUSPIDATA, *Pursh, Fl.* 2, *p.* 741. Western Texas; April.

PSORALEA DIGITATA, *Nutt. in Torr. and Gray, l. c.* Western Texas; April.

DALEA FORMOSA, *Torr. in Am. Lyc. N. York*, 2, *p.* 78; *and in Emory's Rep. t.* 1. Everywhere between the Rio Grande and Western Texas.

PETALOSTEMON VIOLACEUM, *Michx.* Near Fort Washita.

PETALOSTEMON CANDIDUM, *Michx.* Near Fort Washita.

ASTRAGALUS MOLLISSIMUS, *Torr. in Am. Lyc. N. York*, 2, *p.* 178; *Gray, Pl. Wright.* 1, *p.* 53. On the Llano Estacado, in sandy soil; March, April. Plant sometimes considerably caulescent, and a foot high.

ASTRAGALUS SUCCUMBENS, *Dougl. in Hook. Fl. Bor.-Am.* 1, *p.* 151. On the Pecos, Llano Estacado, &c.; March, April. The specimens are only in flower; in which state they very well accord with Douglas' plant. Mr. Gordon also gathered it in flower on the Raton mountains.

ASTRAGALUS PAUCIFLORUS, *Hook. Fl. Bor.-Am.* 1, *p.* 129. High grounds at the head-waters of the Colorado, Texas; April.

ASTRAGALUS MISSOURIENSIS, *Nutt. Gen.* 2, *p.* 99. Guadalupe mountains to the Colorado; March, April.

ASTRAGALUS CYANEUS, *Gray, Pl. Fendl. p.* 34. Between the Pecos and Llano Estacado. Probably too near the preceding species.

ASTRAGALUS NUTTALLIANUS, *DC.*, var. trichocarpus and canescens, *Gray, Pl. Wright.* From the Pecos to the Colorado; March, April.

ASTRAGALUS LINDHEIMERI, *Gray, Pl. Wright.* 1, *p.* 52. On the upper Colorado; April.

ASTRAGALUS CANDENSIS, *Linn.* Near Fort Washita; April.

ASTRAGALUS, *n. sp.?* In flower only. High ground, on the eastern border of the Llano Estacado; April.

OXYTROPIS LAMBERTI, *Pursh, Fl.* 2, *p.* 740. Western Texas; May.

STYLOSANTHES ELATIOR, *Swartz.; DC. Prodr.* 2, *p.* 381. Western Texas; May.

DESMODIUM CANESCENS, *DC. Prodr.* 2, *p.* 238. Near Fort Washita.

LESPEDEZA STUVEI, *Nutt. Gen.* 2, *p.* 107. Near Fort Washita.

SOPHORA SERICEA, *Nutt. Gen.* 1, *p.* 280. Western Texas; April.

CERCIS OCCIDENTALIS, *Torr. in Pl. Lindh.* 2, *p.* 177. Near Fort Chadbourne; May.

HOFFMANSEGGIA STRICTA, var. demissa, *Benth. in Pl. Wright.* 1, *p.* 56. Llano Estacado to the Colorado; April. In flower.

HOFFMANSEGGIA DREPANOCARPA, *Gray, Pl. Wright.* 1, *p.* 58. On the Pecos.

HOFFMANSEGGIA BRACHYCARPA, *Gray, l. c.* On the Pecos.

HOFFMANSEGGIA JAMESII, *Torr. and Gray, Fl.* 1, *p.* 393; *Torr. in Marcy's Rep. t.* 4. Llano Estacado.

CASSIA PUMILIO, *Gray, Pl. Lindh.* 2, *p.* 180; *and Pl. Wright.* 1, *p.* 59. Llano Estacado, &c.; April.

CASSIA BAUHINIOIDES, *Gray, l. c.* Llano Estacado; April.

CASSIA RŒMERIANA, *Scheele; Gray, Pl. Lindh.* 2, *p.* 179. Western Texas; April.

STROMBOCARPA PUBESCENS, *Gray, Pl. Wright.* 1, *p.* 60; (Prosopis, *Benth.*) Near Doña Ana. The fruit only; called *Tornio, or Screw-tree;* in some districts *Screw-bean.*

ALGAROBIA GLANDULOSA, *Torr. and Gray, Fl.* 1, *p.* 399. Head-waters of the Colorado, Texas; April. This is the celebrated *Mezquit* of New Mexico.

DESMANTHUS JAMESII, *Torr. and Gray, Fl.* 1, *p.* 402. Llano Estacado, &c. Foliage only.

SCHRANKIA PLATYCARPA, *Gray, Pl. Lindh.* 2, *p.* 183. Western Texas; April.

MIMOSA BOREALIS, *Gray, Pl. Fendl. p.* 39. On the upper Colorado, and near Fort Chadbourne; April, May.

ACACIA HIRTA, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 404. Western Texas; April.

ACACIA TEXENSIS, *Torr. and Gray, l. c.* (Probably the A. cuspidata, *Schlecht.*) Near Fort Washita.

ROSACEÆ.

PRUNUS AMERICANA, *Marsh.; Torr. and Gray, Fl.* 1, *p.* 407. Big Springs of the Colorado; April.

PRUNUS CHICASA, *Michx.; Torr. and Gray, l. c.* On the Colorado; April.

CERCOCARPUS PARVIFOLIUS, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 427. Doña Ana, New Mexico; February. Foliage only.

FALLUGIA PARADOXA, *Torr. in Emory's Rep. t.* 2. Guadalupe mountains, New Mexico. Foliage only.

GEUM VIRGINIANUM, *Linn.* Western Texas; May.

ROSA SETIGERA, *Michx.; Torr. and Gray, Fl.* 1, *p.* 457. Fort Washita; April.

RUBUS TRIVIALIS, *Michx.; Fl.* 1, *p.* 296. Near Fort Washita.

ONAGRACEÆ.

ŒNOTHERA LAVENDULÆFOLIA, *Torr. and Gray, Fl.* 1, *p.* 501. Llano Estacado; April.

ŒNOTHERA HARTWEGI, *Benth. Pl. Hartw. p.* 1; the var. answering to Œ. Fendleri; *Gray, Pl. Fendl.* On the Pecos, Llano Estacado, and Colorado.

ŒNOTHERA TUBICULA, *Gray, Pl. Wright.* 1, *p.* 71. On the Pecos and Llano Estacado.

ŒNOTHERA ALBICAULIS, *Nutt. Gen.* 1, *p.* 245; *Gray, Pl. Wright.* 1, *p.* 59. On the Pecos.

ŒNOTHERA TRILOBA, *Nutt. Gen. l. c.* On the Pecos.

ŒNOTHERA SERRULATA, *Nutt. l. c.* Big Springs of the Colorado to Fort Washita, &c.; April.

ŒNOTHERA SINNATA, *Linn.* Near Fort Washita; April. Western Texas; May.

ŒNOTHERA WRIGHTII, *Gray, Pl. Wright.* 2, *p,* 57. On the Llano Estacado; April. In flower.

ŒNOTHERA MISSOURIENSIS, *Sims, Bot. Mag. t.* 1592. Western Texas; May.

ŒNOTHERA SPECIOSA, *Nutt.; Torr. and Gray, Fl.* 1, *p.* 496. Western Texas; April.

ŒNOTHERA SPACHIANA, *Torr. and Gray, Fl.* 1, *p.* 498. Western Texas; May.

GAURA PARVIFLORA, *Dougl.; Torr. and Gray, Fl.* 1, *p.* 519. Llano Estacado and Western Texas.

GAURA SUFFULTA, *Engelm. in Pl. Lindh.* 2, *p.* 190. Western Texas.

GAURA COCCINEA, *Nutt.; Torr. and Gray, Fl.* 1, *p.* 518. Llano Estacado.

GAURA SINUATA, *Nutt.; Torr. and Gray, l. c.* Western Texas; April.

CUCURBITACEÆ.

SICYDIUM LINDHEIMERI, *Gray, Pl. Lindl.* 2, *p.* 196. On the Pecos, also Western Texas; March, April.

CUCURBITA PERENNIS, *Gray, l. c.* Western Texas; April. Foliage only.

PASSIFLORACEÆ.

PASSIFLORA INCARNATA, *Linn.; Torr. and Gray, Fl.* 1. *p.* 538. Western Texas; May.

GROSSULACEÆ.

RIBES AUREUM, *Pursh.* Big Springs of the Colorado, &c.; April.

CACTACEÆ.

CEREUS CÆSPITOSUS, ECHINOCACTUS TEXENSIS, and OPUNTIA FRUTESCENS, *Engelm.*, occur in the collection.

UMBELLIFERÆ.

AMMOSELINUM, n. gen. Margin of the calyx obsolete. Petals ovate, entire, nearly plane. Stylopodium very short, as are the diverging styles. Fruit ovate, laterally compressed. Carpels with five equal, prominent, corky, and scabrous ribs, in the intervals of which there are single oil-tubes, and two in the commisure. Carpophore 2-parted. Seed straight, semiterete, slightly concave on the face.—An annual diffuse herb; the leaves decompound with linear ultimate segments; flowers in compound umbels, white; leaflets of the involucre and involucels simple or compound.

AMMOSELINUM POPEI.—Sandy soil; Llano Estacado, and head-waters of the Colorado; March and April. Mr. Wright found it in Western Texas, but he collected only a few specimens, and it was not distributed with his plants. Some ripe seeds that he collected were cultivated in the Cambridge Botanic Garden, and arrived at perfection. Dr. Parry, while engaged on the Mexican boundary survey, under Major Emory, sent home a single flowering specimen of the piant, found at Eagle Pass in January, 1853. From no other sources have we received any specimens of this apparently new genus. It grows about a span in length, and though usually diffuse, some of Captain Pope's specimens must have grown erect, and only a little branched; but they seem to have been crowded together. The stem and branches are angular, and the angles, as well as the midribs of the leaves, are rough; in other respects the plant is nearly glabrous. The leaves are triternally divided, with narrowly linear segments. Umbels compound, or sometimes decompound. Involucre of several leaves, which in strong-growing specimens are large, and resemble the leaves of the stem, being cut into linear segments: the leaves of the involucels are sometimes cut also, but more commonly they are almost entire. Rays of the umbel seldom more than three or four, unequal: rays of the umbellets 8–10, very unequal. Flowers very small. Fruit about two and a half lines long and two lines broad, compressed laterally, so that the longer diameter is twice as great as the shorter; the ribs scabrous with little points. The lateral ones are less prominent, and are confluent with an accessory, thick, corky margin, which extends through the commissure. We have with reluctance added another genus to the already extensive family of Umbelliferæ, already abounding with ill-defined genera, especially as it is founded on a single species. It is most nearly allied to Chaerophyllum, but differs in the entire petals, ovate fruit with acute ribs, and shallow furrows of the seed, as well as in the involucrum.

CYMOPTERUS MONTANUS, *Nutt. in Torr. and Gray, Fl.* 1, *p.* 624; *Gray, Pl. Fendl. p.* 56, *and Pl. Wright,* 1, *p.* 79. Eastern part of the Llano Estacado and on the upper Colorado; April.

POLYTÆNIA NUTTALLII, *DC. Prodr.* 4, *p.* 196. On the Colorado, Texas; April. In flower.

DAUCUS PUSILLUS, *Michx. Fl.* 1, *p.* 164. On the Colorado, Texas; April.

RUBIACEÆ.

OLDENLANDIA (HOUSTONIA) HUMIFUSA, *Gray, Pl. Wright.* 2, *p.* 68. On the Llano Estacado and Pecos; March. A vernal state.

OLDENLANDIA ANGUSTIFOLIA, *Gray, l. c.* Fort Washita and Western Texas; April, May.

GALIUM APARINE, *Linn.* On the Colorado; April. Not in flower.

VALERIANACEÆ.

FEDIA AMARELLA, *Lindh. in Gray, Pl. Lindh.* 2, *p.* 217. On the Colorado, &c., Texas; April, May.

COMPOSITÆ.

MACHÆRANTHERA TANACETIFOLIA, *Nees; Gray, Pl. Wright.* 1, *p.* 90. On the Llano Estacado and Western Texas; March to May.

ERIGERON STRIGOSUM, *Muhl.; Torr. and Gray, Fl.* 2, *p.* 176. Near Fort Washita; April.

ERIGERON DIVERGENS, *Torr. and Gray, l. c.; Gray, Pl. Wright.* 1, *p.* 91. From the Pecos to the Colorado, Texas. Various forms.

DIPLOPAPPUS ERICOIDES, *Torr. and Gray, Fl.* 2, *p.* 182. New Mexico to the Colorado; March, April. Various forms.

TOWNSENDIA SERICEA, *Hook, Fl. Bor.-Am.* 2, *p.* 16, *t.* 119. Guadalupe mountains, New Mexico; March.

CHÆTOPAPPA ASTEROIDES, *DC. Prodr.* 5, *p.* 301. Western Texas; April, May.

APHANOSTEPHUS RAMOSISSIMUS, *DC. Prodr.* 5, *p.* 310; *Gray, Pl. Wright.* 1, *p.* 93; *Torr. in Marcy's Rep. t.* 9. Big Springs of the Colorado; April.

APHANOSTEPHUS ARKANSANUS, *Gray, l. c.* Western Texas; May.

BELLIS INTEGRIFOLIA, *Michx. Fl.* 1, *p.* 131. Western Texas; May.

APLOPAPPUS SPINULOSUS, *DC. Prodr.* 5, *p.* 348. From the Pecos to the Colorado, Texas.

XANTHISMA TEXANUM, *DC. Prodr.* 5, *p.* 94; *Gray, Pl. Wright.* 1, *p.* 98; *Torr. in Marcy's Rep. t.* 10. Western Texas, May.

SOLIDAGO CANADENSIS, *Linn.* Near Fort Washita; April. Not in flower.

CALYMMANDRA CANDIDA, *Torr. and Gray, Fl.* 2, *p.* 262. (Plate II.) Western Texas, on the upper Colorado; April. This has scarcely been collected since it was gathered by Drummond.

FILAGINOPSIS MULTICAULIS, *Torr. and Gray, Fl.* 2, *p.* 263. (Plate III.) On the Pecos and Llano Estacado; March. Western Texas; April. Sterile corollas, naked at the summit, but bearing a few long wooly hairs near the base.

PARTHENIUM HYSTEROPHORUS, *Linn.* Pecos and Llano Estacado.

MELAMPODIUM CINEREUM, *DC. Prodr.* 5, *p.* 518. Banks of the Pecos to the Colorado; March to May.

BERLANDIERA LYRATA, *Benth.; Gray, Pl. Fendl. p.* 78. Llano Estacado, March.

ENGELMANNIA PINNATIFIDA, *Torr. and Gray, in Trans. Amer. Phil. Soc. and Fl.* 2, *p.* 283; *Torr. in Marcy's Rep. t.* 11. Western Texas to the head of the Colorado; April, May.

LINDHEIMERIA TEXANA, *Gray and Engelm. Pl. Lindh.* 2 *p.* 225. Western Texas; April.

ZINNIA MULTIFLORA, *Linn.* Near Fort Chadbourne, Texas.

ECHINACEA ANGUSTIFOLIA, *DC. Prodr.* 5, *p.* 554. Var. Western Texas; April.

SIMSIA (BARRATTIA) CALVA, *Gray, Pl. Lindh.* 2, *p.* 228. On the upper Colorado; April.

DRACOPIS AMPLEXICAULIS, *Cass.; DC. Prodr.* 5, *p.* 558. Near Fort Washita; April.

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ACTINOMERIS HELIANTHOIDES, *Nutt. Gen.* 2, *p.* 181. Near Fort Washita; April.

THELESPERMA FILIFOLIA, *Gray, in Hook. Kew. Jour. Bot.* 1, *p.* 252, *and Pl. Wright.* 1, *p.* 109. Head-waters of the Colorado; April. Also probably T. GRACILIS; but not yet in flower.

COREOPSIS GRANDIFLORA, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 345. On the Colorado; April.

COREOPSIS TINCTORIA, *Nutt.* Near Fort Washita; April.

CHRYSACTINIA MEXICANA, *Gray, Pl. Fendl. p.* 93. Near Independence Spring; March. Without flowers.

HYMENATHERUM (ACIPHYLLÆA) ACEROSUM, *Gray, Pl. Wright.* 1, *p.* 115. On the Pecos and Llano Estacado; March, April.

HYMENATHERUM PENTACHÆTUM, *DC. Prodr.* 5, *p.* 642. On the Pecos; March.

AGASSIZIA SUAVIS, *Gray and Engelm. Pl. Lindh.* 2, *p.* 220. Western Texas; April.

GAILLARDIA AMBLYODON, *Gray; Torr. and Gray, Fl.* 2, *p.* 267; *Gray, Chl. Bor.-Am. t.* 4. Western Texas; April.

GAILLARDIA PINNATIFIDA, *Torr. in Ann. Lyc. New York,* 2, *p.* 214; *Torr. and Gray, Fl.* 2, *p.* 366. Llano Estacado to the Colorado; March, April.

GAILLARDIA PULCHELLA, *Fougeroux; Torr. and Gray, l. c.* Western Texas; April.

HYMENOPAPPUS CORYMBOSUS, *Torr. and Gray, Fl.* 2, *p.* 272. On the Colorado, &c.; April.

BAHIA ABSINTHIFOLIA, *Benth.* var. DEALBATA, *Gray, Pl. Wright.* 1, *p.* 121. On the Pecos; March.

RIDDELLIA TAGETINA, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 262; *Torr. in Emory's Rep. t.* 5. Llano Estacado; March.

AMBLYOLEPIS SETIGERA, *DC. Prodr.* 5, *p.* 568; *Gray, Pl. Wright.* 1, *p.* 121. From the Llano Estacado to the lower Colorado; March, April.

ACTINELLA SCAPOSA, *Nutt. in Torr. and Gray, Fl.* 2, *p.* 382. On the Pecos and Llano Estacado; March.

ACTINELLA LINEARIFOLIA, *Nutt.; Torr. and Gray, l. c.* On the Pecos.

ACTINELLA RICHARDSONII, *Nutt.* Picradenia Richardsonii, *Hook.* Near the Pecos; March.

HELENIUM TENUIFOLIUM, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 385. Western Texas; April.

MARSHALLIA CÆSPITOSA, *Nutt. in DC. Prodr.* 5. *p.* 680. On the upper Colorado; April.

ACHILLEA MILLEFOLIUM, *Linn.* Near Fort Washita and on the Colorado.

ARTEMISIA DRACUNCULOIDES, *Pursh; Torr. and Gray, Fl.* 2, *p.* 216. Sacramento river to the Llano Estacado; March.

ARTEMISIA LEWISII, *Torr. and Gray, Fl.* 2, *p.* 217. Pecos to the Llano Estacado; March.

ARTEMISIA LUDOVICIANA, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 420. Cotton-wood Springs, New Mexico, &c.; March.

GNAPHALIUM LUTEO-ALBUM, *Linn.* New Mexico and Western Texas.

SENECIO FILIFOLIUS, *Nutt.* var. JAMESII, *Torr. and Gray, Fl.* 2, *p.* 444. On the Pecos and upper Colorado.

SENECIO LOBATUS, *Pers.; Torr. and Gray, l. c.* Western Texas; April.

CIRSIUM VIRGINIANUM, *Michx. Fl.* 2, *p.* 90. Western Texas; April.

CIRSIUM UNDULATUM, *Spreng.; DC. Prodr.* 6, *p.* 651. Llano Estacado, &c.

CENTAUREA AMERICANA, *Nutt.* Near Fort Washita; April.

PEREZIA NANA, *Gray, Pl. Fendl. p.* 111. On the Pecos; March. The foliage only.

APOGON HUMILIS, *Ell. Sk.* 2, *p.* 267. Western Texas; May.

KRIGIA OCCIDENTALIS, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 467. Western Texas; May.

PINAROPAPPUS ROSEUS, *Less.; DC. Prodr.* 7, *p.* 99. Western Texas; April.

LYGODESMIA APHYLLA, *DC.* var. TEXANA, *Torr. and Gray, Fl.* 2, *p.* 484. Western Texas; April.

PYRRHOPAPPUS GRANDIFLORUS, *Nutt.; Torr. and Gray, Fl.* 2, *p.* 495. Big Springs of the Colorado, &c.; April.

CAMPANULACEÆ.

DYSMICODON OVATUM, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 8, *p.* 256. Specularіæ sp. *Torr. Mss.* Western Texas; April to May.

DYSMICODON PERFOLIATUM, *Nutt. l. c.* Campanula perfoliata, *Linn.* Specularia perfoliata, *Alph. DC. Prodr.* 7, *pars* 2, *p.* 490, (in part.) With the preceding.

PLANTAGINACEÆ.

PLANTAGO VIRGINICA, *Linn.* Llano Estacado, and on the Colorado; March, April.

PLANTAGO GNAPHALIOIDES, *Nutt. Gen.* 1, *p.* 100. On the Pecos; March.

PRIMULACEÆ.

DODECATHEON MEADIA, *Linn.* Western Texas; May.

ACANTHACEÆ.

STENANDRIUM BARBATUM, (n. sp.; Plate IV): dwarf, multicipital, bearded all over with long and shaggy white hairs; scape at first shorter than the oblanceolate, or narrowly spatulate, entire, and scarcely petioled radical leaves; bracts oblong-lanceolate, acute, entire, nearly equalling the corolla; anthers bearded on the back and tip; stigma funnel-form, its oblong margin not ciliate; capsule oblong, 4-seeded. On the Pecos; March. First collected by Mr. Wright on a lower part of the same river. It is No. 1423 of his distributed collection.

DIPTERACANTHUS STREPENS, *Nees in DC. Prodr.* 11, *p.* 121. Western Texas; April, May.

CALOPHANES OBLONGIFOLIUS, *Don; Nees in DC. Prodr.* 11, *p.* 107, and var. TEXENSIS, *Nees.* Western Texas; April, May.

SCROPHULARIACEÆ.

LINARIA CANADENSIS, *Don.* On the Pecos, Llano Estacado, and Western Texas; March, May.

VERONICA PEREGRINA, *Linn.* Llano Estacado, &c.; March.

PENTSTEMON COBÆA, *Nutt.; Benth. in DC. Prodr.* 10, *p.* 326. Western Texas; April, May.

PENTSTEMON GRANDIFLORUS, *Nutt. in Fras. Cat.; Benth. in DC. l. c.* Near Fort Chadbourne; May.

PENTSTEMON ALBIDUS, *Nutt. Gen.* 2, *p.* 53. Upper Colorado, Texas; April.

PENTSTEMON FENDLERI, (n. sp.; Plate V): erect, glabrous throughout, glaucous; leaves coriaceous, entire, the radical ones ovate or obovate, and tapering into a short petiole, the cauline ovate or oblong, and closely sessile; flowers cymulose, or sometimes subsolitary in the axils of the upper leaves and obovate bracts, forming a strict interrupted panicle or series of apparent verticils; segments of the calyx ovate, with scarious margins; corolla (blue or purple) funnel-form, scarcely bilabiate, sparsely bearded or smooth in the throat; sterile filament dilated and densely (yellow) bearded at the summit. On the Pecos and Llano Estacado; March, April. A species which occurs in all the collections made in this region, and is considerably variable in size, foliage, the number of the flowers, (which are handsome, and eight or ten lines long,) the size of the bracts, &c. It is most nearly related to P. acuminatus and P. nitidus, especially to the latter.

STENANDRIUM BARBATUM.

P. S. Duval & Co Lith. Phil.ª

PENTSTEMON FENDLERI

Sprague del. P.S.Duval & Co Lith. Philad.a Prestele sc

SALVIASTRUM TEXANUM.

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PENTSTEMON PUBESCENS, *Soland.; DC. Prodr.* 10, *p.* 327. Western Texas; May.

CASTILLEJA PURPUREA, *Don; DC. Prodr.* 10, *p.* 531. Llano Estacado and Western Texas; March, April.

VERBENACEÆ.

VERBENA BIPINNATIFIDA, *Engelm. and Gray, Pl. Lindh.* 1, *p.* 49; *Schauer, in DC. Prodr.* 11, *p.* 553. Glandularia bipinnatifida, *Nutt.* Delaware creek to the Colorado; March, April.

VERBENA AUBLETIA, *Linn.* Upper Texas, &c.; April.

VERBENA BRACTEOSA, *Michx. Fl.* 2, *p.* 14. On the Pecos and Llano Estacado; March.

VERBENA OFFICINALIS, *Linn.* V. spuria, *Linn.*, etc. Western Texas; April, May.

LABIATÆ.

SALVIA FARINOSA, *Benth. Lab. p.* 274. On the Colorado; April. Probably not distinct from S. Pitcheri, *Torr.*

SALVIASTRUM TEXANUM, *Scheele, in Linnæa.* 22, *p.* 584. (Plate VI.) Gravelly soils, Llano Estacado; April. A common plant in Texas and New Mexico.

SCUTELLARIA RESINOSA, *Torr. in Ann. Lyc. New York,* 2, *p.* 232. On the Pecos and the headwaters of the Colorado; April.

TEUCRIUM CANADENSE, *Linn.; Benth. in DC. Prodr.* 12, *p.* 581. Near Fort Washita.

TEUCRIUM CUBENSE, *Linn.; Benth. l. c.; Torr. in Marcy's Rep. p.* 293. On the Pecos, &c.; April.

MONARDA ARISTATA, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 5, *p.* 186. In clayey soil; Western Texas. Annual.

MONARDO MOLLIS, *Nutt. l. c.* Near Fort Washita. Seems to be distinct from M. fistulosa.

BORAGINACEÆ.

STEGNOCARPUS, *DC.* (a section of COLDENIA). Calyx deeply 5-cleft; the lobes lanceolate-subovate. Corolla funnel-salverform; the throat naked; border 5-lobed, flat. Stamens five, inserted into the tube of the corolla. Style filiform, terminal, 2-parted: stigmas capitate. Ovary ovate, slightly 4-lobed. Fruit globose-quadrangular, depressed, consisting of four closely joined nutlets which are even, glabrous, (except a slight hairiness at the summit when young,) and at length separate.—A prostrate, much-branched, small under-shrub, canescent with appressed hairs. Leaves numerous, small, ovate, and petiolate. Flowers axillary, solitary or somewhat clustered, sessile, white.

S. CANESCENS, *Torr. in Emory's Rep. of Mex. Bound. Commiss.* (*ined.*) Coldenia (sect. Stegnocarpus) canescens, *DC. Prodr.* 9, *p.* 559. (Plate VII.) In decomposing gypseous gravel, on the Pecos. It is common in the valley of the Rio Grande, from El Paso to Monterey. Dr. Edwards found it near the latter place. It is the same as No. 1554–1556 of Wright's New Mexican collection. De Candolle founded the species and subgenus on specimens collected in Mexico by Berlandier, and numbered 2256* in his collection. He states that the stamens are inserted at the summit of the tube of the corolla, and that the nutlets are silky-pubescent; whereas we found the stamens inserted near the base of the tube, and the nutlets glabrous. We therefore at first supposed our plant to be a distinct species, and called it S. leiocarpa. Having, however, recently obtained original specimens of Berlandier's No. 2256, we found that only the young fruit is a little pubescent near the summit. As to the insertion of the filaments, no great reliance is to be placed on that character in this family, owing to the tendency to a kind of dioicality that occurs in a number of the genera, such as has long been

* No. 2389 of Berlandier's Collection is the same plant.

known to exist in certain Labiatæ and Rubiaceæ. De Candolle (l. c.) asks whether his section Stegnocarpus of Coldenia ought not to constitute a proper genus. If he had had as complete a series of specimens as we possess, no doubt he would have made the separation. It belongs to the tribe Ehretieæ, but has a fruit like that of some Eritrichia. The Stegnocarpus has a decidedly woody base, and seems to be usually prostrate. The leaves are 5–8 lines long (including the petiole) and 1–3 lines broad, ovate or oblong, rather acute at each end, and thickly clothed with appressed whitish hairs. The flowers are often solitary, but sometimes two or three together. Calyx 5-parted below the middle; the lobes subulate from a rather broad base. Corolla about four lines long; the tube ample, and a little longer than the calyx; the lobes crenulate. Stamens five, rather unequal: filaments subulate, usually inserted near the base of the corolla: anthers oblong. Ovary scarcely lobed: style compressed, about as long as the stamens, cleft to the middle; the segments filiform, erect, strongly capitate. Fruit consisting of four closely fitting nutlets, which separate at maturity. When young, there is often more or less pubescence towards the summit; but it finally disappears, and the fruit becomes smooth and shining on the back. The sides (where they come in contact) are somewhat wavy. The pericarp is coriaceous, and there is little or no albumen.

PTILOCALYX, (n. gen.) Calyx 5-parted nearly to the base; the segments subulate-filiform, plumose with spreading hairs. Corolla campanulate-salverform; the throat naked. Stamens five, inserted near the base of the tube. Ovary somewhat 4-lobed, 4-celled, with an obscure glandular ring at the base. Style filiform, terminal, 2-parted: stigmas minute, simple. Fruit coriaceo-chartaceous, one-celled (by abortion), with vestiges of three other cells. Seed solitary, terete; the embryo with little or no albumen. A low, much branching shrub, with small, ovate, entire, and somewhat fascicled leaves, and white flowers in short capitate terminal spikes. The name alludes to the feathery segments of the calyx.

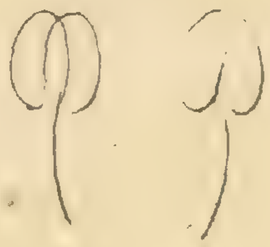
Ptilocalyx Greggii. (Plate VIII.) Western Texas; April. Common in New Mexico; *Mr. Wright and Dr. Parry.* (It is No. 492 of Mr. Wright's distributed collection.) Near Buena Vista, &c., Mexico; *Dr. Gregg.* A shrub of an ashy gray color, sometimes attaining the height of three feet, the bark separating in loose shreds. Leaves 3–5 lines long, thickish, on short petioles, revolute when dry. Heads of flowers half an inch in diameter. Calyx longer than the corolla; the segments villous-plumose with spreading hairs. Corolla white; the border obtusely 5-lobed. Stamens equal, included; filaments subulate, glabrous; anthers ovate, 2-celled. Ovary globose-ovate, glabrous, 4-celled, with an ovule suspended from the summit of each cell. Style 2-cleft about one third of its length. Fruit brown and shining, retrorsely hispid near the summit, crowned with the persistent style; only one of the cells fertile, the others very indistinct and collapsed; their place being indicated externally by a broad stripe on one side. This plant, which seems to have been hitherto undescribed, agrees in many respects with Ehretia; but differs in the remarkable fruit, which is unlike that of any other Boraginea.

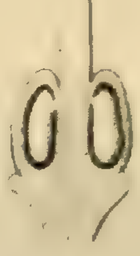
EDDYA, (n. gen.) Calyx deeply 5-parted. Corolla salver-form, with the throat naked. Stamens inserted towards the summit of the tube of the corolla. Style terminal, elongated, 2-cleft: stigmas capitate. Ovary 4-lobed. Nutlets 4, globose-ovate, cohering by the inner angle, but finally separating, muriculate-scabrous. Cotyledons ovate, entire: radicle very short: albumen none, or very thin.—A small, prostrate, much branched, and very hispid undershrub, with crowded linear entire revolute leaves, and small axillary and solitary white flowers. Named in memory of Caspar Wistar Eddy, M. D., formerly of New York, a zealous and promising botanist, who died young, soon after publishing a catalogue of the plants growing around Plandome, Long Island.

Eddya hispidissima. (Plate IX.) Ehretia? hispida, of the 1st edition of this report. Common on the Rio Grande about El Paso. It is the same as No. 845 of Mr. Wright's Texan collection, (1849) and No. 1557 of his New Mexican collection. The plant is much branched from the base, which is decidedly woody. Leaves 3-5 lines long, acute, and very hispid with

PTILOCALYX GREGGII

P.S. Duval & Co. Lith. Phila.





EDDYA HISPIDISSIMA.

Sprague del. P.S.Duval & Co Lith. Phila. Prestele ac

rigid whitish hairs: towards the summit of the numerous short branches they are much crowded, so as to appear fasciculate. Flowers sessile, 2-3 lines long. Calyx hispid, like the leaves; the tube somewhat indurated in fruit. Stamens unequal, included. Style cleft about one third of the way down, about as long as the stamens. Nutlets scarcely one third of a line in diameter, two or three of them usually abortive, of a dull gray color, roughened with very minute papilllæ; the endocarp crustaceous and brittle.—Nearly allied to Tiquilia of Persoon, a genus very distinct from Coldenia, to which it was referred as a subgenus, with a mark of doubt, by De Candolle. Both genera seem to be more allied to the tribe Borageæ than to Ehretieæ.

Heliotropium Curassavicum, *Linn.; DC. Prodr.* 9, *p.* 538. Pecos to Llano Estacado; March to April.

Onosmodium Bejariense, *DC. Prodr.* 10, *p.* 70. Western Texas; May.

Pentalophus longiflorus, *Alph. DC. Prodr.* 10, *p.* 86. Batschia longiflora, *Nutt. Gen.* 1, *p.* 114. Gravelly soil; Llano Estacado, &c.; March to April.

Lithospermum breviflorum, *Engelm. and Gray, Pl. Lindheim, part* 2, *no.* 278. Gravelly soil, on the Pecos; April.

Eritrichium Jamesii, *Torr. in Marcy's Rep. p.* 294. Myosotis suffruticosa, *Torr. in Ann. Lyc., New York*, 2, *p.* 225. Sandy soil, Llano Estacado; March.

Eritrichium multicaule, *Torr. in Marcy's Rep. l. c.* On the Pecos; March.

Eritrichium crassisepalum, (n. sp.): annual, very hispid with spreading hairs; stem branching from the base; the branches ascending; leaves obovate-lanceolate, rather obtuse; racemes bracteate (except the upper portion); flowers on short pedicles; fructiferous calyx ventricose at the base, closed and contracted above the middle, the segments thickened and indurated on the back; nutlets heteromorphous, ovate, acute, convex on the back, three of them muriculate-granulate, the fourth larger and nearly or quite glabrous. On the Pecos, Llano Estacado, &c.; in sandy soil; March. A common species in Western Texas and New Mexico. It was found by Frémont on the Upper Platte. It is the same as No. 640 of Fendler's New Mexican collection. The flowers are white and variable in size, being in some specimens minute, and not much longer than the calyx, and in others quite conspicuous, as in the section Cryptantha of Alph. DC. This species, however, belongs to the section Rutidocaryum, as does the following.

Eritrichium pusillum, (n. sp.): annual, dwarfish, hispidly pilose; stem branching from the base; leaves spatulate-linear; racemes many-flowered, ebracteate; flowers sessile, approximate; calyx deeply 5-parted, the segments lanceolate and very hispid; corolla about as long as the tube of the calyx; nutlets ovate-subtriangular, acute, verrucose-granulate on the back. Rio Pecos to Llano Estacado; March. It is the same as No. 1571 of Mr. Wright's New Mexican collection. A very small species, being not more than two or three inches high even in fruit. It either branches from the base, or throws up numerous simple stems, which are somewhat spreading. The flowers are minute and white. The nutlets are light brown, scarcely one third of a line long, and roughened with somewhat distant granules or papillæ.

Echinospermum patulum, *Lehm.; DC. Prodr.* 10, *p.* 137. Common in Western Texas.

Echinospermum strictum, *Nees, in Maximill. Trav. App.* Cynoglossum pilosum, *Nutt. Gen.* 1, *p.* 114? Llano Estacado; March to April. The nutlets are armed with 6-8 strong and short prickles on each side of an obtuse border surrounding a deep open cavity in front of each. Sometimes one of the nutlets is of a different form from the others. De Candolle refers Nuttall's Cynoglossum pilosum to Pectocarya pencillata, not from having seen the plant, but because it was said to resemble so strongly the figure of that species in the Flora Peruviana; but Mr. Nuttall (in Plant Gamb.) says it is "a true Myosotis," or rather an Eritrichium; so that it is wholly unlike Pectocarya.

HYDROPHYLLACEÆ.

PHACELIA INTEGRIFOLIA, *Torr. in Ann. Lyc. New York*, 2, *p.* 222, *t.* 3. Delaware creek to the Pecos; March. Barely commencing to flower.

PHACELIA POPEI, (n. sp.; Plate X): vicosely pubescent, hispidulous with spreading hairs; leaves bipinnately parted, or pinnately cut, the circumscription linear-oblong; segments oblong, pinnatifid; the lobes 5–9, short and obtuse; spikes corymbose, densely flowered; segments of the calyx spatulate, about half the length of the campanulate corolla, and a little longer than the globose capsule; stamens somewhat exserted. On the Llano Estacado and Pecos, in gravelly soil; March and April. Stem four inches to a foot high from a biennial root, hispid, as are the branches, &c., with rather small and weak bristly hairs. Leaves 2–4 inches long; the primary divisions 3–10 lines long, or the lower ones more reduced in size, on the radical leaves barely a line or so in length, clothed with a minute and almost viscid pubescence, with stronger hairs intermixed; the lobes oval or oblong, very obtuse, entire or 2–3-toothed. Spikes an inch or more in length, not much elongated in fruit, dense; the flowers sessile, or nearly so. Calyx viscid-pubescent and hirsute rather than hispid; the segments spatulate, obtuse, a line and a half long, little increased in fruit. Corolla apparently white, about five lines in diameter when expanded; the rounded lobes entire or obsoletely crenulate; the ten appendages at the insertion of the filaments reduced to very short and rounded teeth. Filaments naked, at first slightly, at length considerably exserted. Style nearly naked. Ovary hirsute-pubescent. Capsule a line or a line and a half in diameter. Seeds four, oval, with the inner face strongly bilunate; the central keel very prominent. Albumen conformed to the testa. Fruiting specimens of this very distinct Phacelia are in Wright's collection, (No. 1578.) An abundance of flowering specimens were gathered by Dr. Garrard, as well as by Captain Pope, whose name we desire the species to bear.

POLEMONIACEÆ.

GILIA LONGIFLORA, *Don; Torr. in Sitgreaves' Exped. t.* 7. On the Pecos and Llano Estacado; March.

GILIA RIGIDULA, *Benth. in DC. Prodr.* 9, *p.* 312. Llano Estacado and upper Colorado.

GILIA CORONOPIFOLIA, *Pers.; Benth. in DC. l. c.* Llano Estacado and near Fort Washita; March, April.

PHLOX DRUMMONDII, *Hook. Bot. Mag. t.* 3441; *Benth. l. c.* Western Texas; May.

PHLOX PILOSA, *Linn.; Benth. l. c.* Western Texas; May.

CONVOLVULACEÆ.

EVOLVULUS ARGENTEUS, *Pursh, Fl.* 1, *p.* 187. On the upper Colorado, Texas; April.

CONVOLVULUS LOBATUS, *Engelm. and Gray, Pl. Lindh.* 1, *p.* 44. On the Colorado, Texas; April.

SOLANACEÆ.

SOLANUM ELÆAGNIFOLIUM, *Cavan. Ic. t.* 243; *Dunal. in DC. Prodr.* 13, *p.* 290. S. Texense, *Engelm. and Gray, Pl. Lindh.* 1, *p.* 19. S. Rœmerianum, *Scheele in Linnœa.* 21, *p.* 767. S. flavidum, *Torr. in Ann. Lyc. New York*, 1, *p.* 227. Western Texas; April, May.

SOLANUM ———, the S. mammosum, *Engelm. and Gray, Pl. Lindh. l. c.*, and the S. platyphyllum, *Torr. in Ann. Lyc.*? Western Texas; April. Not yet identified with any in De Candolle's Prodromus.

SOLANUM ROSTRATUM, *Dunal, Solan. t.* 24; *and in DC. Prodr.* 13, *p.* 329. S. heterandrum, *Pursh, Fl.* 2. *p.* 731, *t.* 7. Western Texas; May.

PHACELIA POPEI

Sprague del.

F.S. Durand & Co. Lith. Phila.

PHYSALIS LOBATA, *Torr. in Ann. Lyc. New York*, 1, *p.* 226. On the Pecos and Llano Estacado; March, April. Several forms, including, perhaps, more than one species. They are not true species of Physalis. We know not what Dunal has done with them; but he must have seen specimens in Berlandier's and other collections. There is also a genuine Physalis from Upper Texas, but not in a condition to name.

NICOTIANA RUSTICA, *Linn.*? Upper Colorado, Texas; April.

GENTIANACEÆ.

SABBATIA CAMPESTRIS, *Nutt. in Trans. Amer. Phil. Soc.; DC. Prodr.* 9. *p.* 50. Near Fort Washita; April.

JASMINACEÆ.

MENODORA HETEROPHYLLA, *Moricand, in DC. Prodr.* 8, *p.* 316; *Gray, in Sill. Jour.* 14, 1852. Western Texas; April. This is, doubtless, the Boliviara Grisebachii, *Scheele in Linnæa.* 25, *p.* 254.

APOCYNACEÆ.

AMSONIA CILIATA, *Walt. Fl. Car. p.* 98. On the upper Colorado; April.

AMSONIA SALICIFOLIA, *Pursh, Fl.* 1, *p.* 184. On the Pecos. Only the broad-leaved form was in the collection.

ASCLEPIADACEÆ.

ASCLEPIAS TUBEROSA, *Linn.; Michx. Fl.* 1, *p.* 117; var. angustifolia. Western Texas; May 10.

ACERATES PANICULATA, *Decaisne, in DC. Prodr.* 8, *p.* 521. Anantherix paniculatus, *Nutt.* Sandy soil, head-waters of the Colorado; April. This is the snake-weed of the Camanche Indians.

ACERATES VIRIDIFLORA, *Ell. Sk.* 1, *p.* 317. Var. 1. Leaves broadly ovate, mucronate, somewhat fleshy, smoothish. Var. 2. Leaves narrowly ovate, acute, somewhat hoary-pubescent. Llano Estacado.

ACERATES LONGIFOLIA, *Ell. l. c.; Decaisne, l. c.* Big Springs of the Colorado and Llano Estacado, in gravelly soil; April.

GONOLOBUS BIFLORUS, *Nutt. in herb. DC.* Chthamalia biflora, *DC. l. c. p.* 605. With the preceding.

CHENOPODIACEÆ.

OBIONE CANESCENS, *Moq. Chenop. p.* 74. Atriplex canescens, *Nutt. Gen.* 1, *p.* 197. Mesilla valley, and from Delaware creek to Sacramento river; March.

OBIONE CONFERTIFLORA, *Torr. and Frem. in Frem. 2d Report, p.* 318. Gravelly soil, head-waters of the Colorado.

OBIONE ARGENTEA, *Moq. Chenop. p.* 76. Atriplex argentea, *Nutt. Gen.* 1, *p.* 198. Llano Estacado.

ANTHROCNEMUM FRUTICOSUM, *Moq. Chenop. p.* 111, *and in DC. Prodr.* 13, *p.* 181?; *Torr. in Stansb. Rep. p.* 394. In a saline, decomposed, gypseous soil, also on the borders of a salt lake on the Guadaloupe mountains.

CHENOPODINA MARITIMA, *Moq. in DC. Prodr.* 13, (*pars.* 2,) *p.* 164. Sueda maritima, *Dumort.* Chenopodium maritimum, *Linn.* Saline soils between the Pecos and Llano Estacado. Not in flower.

PHYTOLACCACEÆ.

PHYTOLACCA DECANDRA, *Linn.* Near Fort Washita; April.

POLYGONACEÆ.

POLYGONUM LAPATHIFOLUM, *Linn.? Willd. Sp. pl.* 2, *p.* 442. Near Fort Washita. Perhaps not distinct from P. Persicaria.

ERIOGONUM LONGIFOLIUM, *Nutt. in Trans. Amer. Phil. Soc.* (*n. ser.*) 5, *p.* 164. E. Texanum, *Scheele.* Gravelly soil, on the Pecos; April.

ERIOGONIUM CERNUUM, *Nutt. in Pl. Gambel.?* Llano Estacado, sandy soil. It differs in the pubescence of the leaves being rougher and more persistent.

RUMEX VENOSUS, *Pursh, Fl. supp.* 2, *p.* 733. Delaware creek, and along the Pecos; March.

RUMEX ACETOSELLA, *Linn.; Pursh, Fl.* 1, *p.* 249. Western Texas. Probably introduced.

RUMEX BRITANNICA, *Linn.; Torr. Fl. New York,* 2, *p.* 155. Western Texas.

NYCTAGINACEÆ.

ABRONIA CYCLOPTERA, *Gray, in Sill. Jour.* (*n. ser.*) 15; *Torr. in Marcy's Rep. t.* 18. Llano Estacado to Fort Chadbourne; April, May. In flower only.

OXYBAPHUS ANGUSTIFOLIUS, *Torr. in Amer. Lyc. New York,* 2, *p.* 237. On the upper Colorado; April.

OXYBAPHUS HIRSUTUS, *Sweet; Hook. Fl. Bor.-Am.* 2, *p.* 124. On the Colorado; April.

ACLEISANTHES BERLANDIERI, *Gray, in Sill. Jour. l. c.* On the Pecos; March, Foliage only.

EUPHORBIACEÆ.

TRAGIA RAMOSA, *Torr. in Ann. Lyc. New York,* 2, *p.* 245. Gravelly soils; March.

CNIDOSCOLUS STIMULOSUS, *Engelm. and Gray, Pl. Lindl., part* 1, *p.* 26. Sand-hills of Llano Estacado and Western Texas; March to May. Flowers larger than in the eastern plant.

STILLINGIA LANCEOLATA, *Nutt. in Trans. Phil. Soc.,* (*n. ser.*) 5, *p.* 176. Sandy soil, Western Texas; April to May.

HENDECANDRA CROTONOIDES, *Hook. and Arn. Bot. Beech, p.* 388. This is the same as No. 1800, Pl. Wright. It was found also by Frémont on the Gila. It is quite a distinct species from H. procumbens. The Mexicans call it *Yerba del Gato,* and use it as a purgative.

EUPHORBIA ARKANSANA, *Engelm. and Gray, l. c. no.* 303. Intermediate between E. platyphylla and E. Helioscopia. Sandy soil. Collected in a journey to Fort Chadbourne, and on the head-waters of the Colorado.

EUPHORBIA GEYERI, *Engelm. and Gray, Pl. Lindh.* 1, *p.* 52. Western Texas; May.

EUPHORBIA WRIGHTII, (n. sp.): stem herbaceous from a somewhat ligneous base, erect, much branched; leaves opposite, sessile, narrowly lanceolate-linear, entire; involucres solitary, pedunculate, mostly terminal or in the uppermost forks of the stem, pubescent; glands transversely oblong, entire, with a large petaloid broadly obovate denticulate appendage; capsule very minutely papillose-pubescent; seeds glabrous. Head-waters of the Colorado; April. This is the same as No. 1827 of Mr. Wright's New Mexican collection, (1851–52). It is about a foot high, branching from the base; the branches green and angular. Leaves an inch or more in length, and 2–3 lines wide. Peduncles variable in length, occasionally 2–3 times longer than the hemispherical involucre, but usually shorter. Petaloid appendages conspicuous. Styles very short, spreading, 2-cleft about half-way down. Capsule coriaceous. Seeds subglobose.

EUPHORBIA ALBOMARGINATA, (n. sp.): perennial, slender, much branched, smooth; leaves stipulate, opposite, suborbicular, subcordate, entire, distinctly petiolate; involucre solitary, shorter

than the peduncles; glands transversely oval, with an entire or slightly crenate petaloid border, which is twice as broad as the gland itself; seeds obovate, somewhat rugose transversely, dull, gelatinous when moistened. In red sand and clay: with the preceding. Resembles the following, but more slender and of a more diffuse habit. It is readily distinguished by the broad petaloid appendages of the involucral glands.

EUPHORBIA DILATATA, (n. sp.): whole plant clothed with a soft pubescense; stem much branching from a somewhat woody base, diffuse; leaves without stipules, opposite, ovate, sessile, dilated and somewhat unequal at the base, rather obtuse, entire, (often purplish underneath) thickish; involucres mostly solitary, axillary and terminal, nearly sessile, ovate; glands transversely linear-oblong, with a narrow petaloid crenate margin; capsule somewhat hairy; seeds oblong, even, gelatinous when moistened. Western Texas. Not uncommon in New Mexico. Resembles No. 1840 of Mr. Wright's New Mexican collection, (1851–52); but that is hairy, the leaves are lanceolate, tapering to a mucronate tip, and the petaloid appendages of the involucral glands are much broader.

EUPHORBIA FENDLERI, (n. sp.): branching and diffuse from a somewhat woody candex, smooth; leaves stipulate, opposite, broadly ovate or orbicular-ovate, on very short petioles, subcordate and oblique at the base; involucres solitary, on short peduncles; gland transversely oval, with a narrow entire somewhat 2-lobed border; capsule smooth; seeds obovate, a little rugose transversely, gelatinous when moistened. Big Springs of the Colorado; April. This species is No. 800 of Fendler's New Mexican collection. It is a small plant, throwing off many branches that spread on the ground, forming a little patch from three to six inches in diameter. The leaves are 3–4 lines long, and are often of a purplish tinge, especially underneath.

SANTALACEÆ.

COMANDRA UMBELLATA, *Nutt. Gen.* 1, *p.* 157. Gravelly soil. Big Springs of the Colorado, &c., Texas; April.

SALICACEÆ.

SALIX. Two undetermined species were found in the sand-hills of Llano Estacado.

CUPULIFERÆ.

QUERCUS UNDULATA, *Torr. in Ann. Lyc. New York*, 2, *p.* 248, *t.* 4. Head-waters of the Colorado and Llano Estacado; in sandy soil. In flower April 12.

QUERCUS PALUSTRIS, *Du Roi*. Near Fort Chadbourne, Texas.

URTICACEÆ.

PARIETARIA PENNSYLVANICA, *Willd?* Delaware creek to the Pecos; March.

CELTIS RETICULATA, *Torr. in Ann. Lyc. New York*, 2, *p.* 247. Upper Colorado, Texas; April.

PLANERA RICHARDI, *Michx. Fl.* 2, *p.* 248. Western Texas; April.

MORUS RUBRA, *Linn.?* Near Fort Washita; April.

CONIFERÆ.

EPHEDRA ANTISIPHILITICA, *Berland.; Endl. Conif. p.* 263. High rocky and sandy places; Llano Estacado and on the Pecos. The fertile aments are 1–2-flowered; but usually perfect only one seed, which in that case is triangular. When two seeds ripen they are less angular, and the opposite faces are flat. The scales of the ament become fleshy at maturity.

JUNIPERUS VIRGINIANA, *Linn.; Michx. f. Sylv.* 2, *p.* 253, *t.* 155. Head-waters of the Colorado, and in various parts of Western Texas.

SMILACEÆ.

SMILAX HASTATA, *Willd. Sp. p.* 782; *Ell. Sk.* 2, *p.* 696. High plains, Llano Estacado.

COMMELYNACEÆ.

TRADESCANTIA VIRGINIANA, *Linn.; Kunth, Enum.* 4, *p.* 81. Head-waters of the Colorado and on the Pecos; March and April. Very variable as to size, pubescence, and breadth of the leaves.

COMMELYNA ANGUSTIFOLIA, *Michx. Fl.* 1, *p.* 24. Near Fort Washita.

IRIDACEÆ.

SISYRINCHIUM BERMUDIANA, *Linn.;* var. anceps. S. anceps, *Cav.* Dry soils, Llano Estacado.

LILIACEÆ.

CAMASSIA FRASERI, *Torr. in Whipple's Report, ined.* Scilla esculenta, *Gawl. in Bot. Mag., t.* 1574; (excl. syn. *Pursh.*) *β.* angusta. S. angusta, *Engelm. and Gray, Pl. Lindheim., part* 1, *No.* 198. Western Texas.

ALLIUM MUTABILE, *Michx. Fl.* 1, *p.* 195. On the Pecos and the head-waters of the Colorado; March to April. Flowers varying from deep rose red to nearly white.

PSEUDOSCORDUM STRIATUM, *Herb.* Nothoscordum striatum, *Kunth, Enum.* 4, *p.* 458. Allium striatum, *Jacq.* With the preceding.

YUCCA ANGUSTIFOLIA, *Pursh, Fl.* 1, *p.* 227. On the Pecos; April. Flowers in a long, narrow raceme, as large as in *Y. filamentosa*, greenish yellow mixed with purple.

JUNACEÆ.

JUNCUS TENIUS, *Willd.; Torr. Fl. New York,* 2, *p.* 329. Low grounds. Hueco Tanks.

NARIADACEÆ.

POTAMOGETON PRÆLONGUS, *Wulf.; Gray, Bot. North. States, p.* 456. Western Texas.

CYPERACEÆ.

SCIRPUS LACUSTRIS, *Linn.; Torr. Cyp., p.* 321. In water; Llano Estacado; March.

ELEOCHARIS OBTUSA, *Schultes; Torr. l. c., p.* 302. With the preceding.

GRAMINEÆ.

CERATOCHLOA UNIOLOIDES, *Beauv. Agrost. p.* 75, *t.* 15, *f.* 7. Bromus Willdenovii, *Kunth, Enum.* 1, *p.* 416. Head-waters of the Colorado; April.

TRIPSACUM DACTYLOIDES, *Linn. fil. Decad.* 17, *t.* 9; *Steud. Pl. Glum. p.* 362. Llano Estacado. A tall rank grass, affording good fodder.

CHLORIS VERTICILLATA, *Nutt. in Trans. Amer. Phil. Soc.* (n. ser.) 5, *p.* 143. Sandy plains northeast of the Pecos; April. *β.?* ARISTULATA; spikes much shorter; awns scarcely half the length of the paleæ; lower glume obovate, rather obtuse. With the preceding. Not uncommon at the lower Rio Grande, where it was collected by Dr. Gregg, who says it is good fodder. The spikes are usually purplish, but sometimes yellowish.

PANICUM PAUCIFLORUM, *Ell. sk.* 1, *p.* 120? On the Pecos; April.

PHALARIS ANGUSTA, *Nees; Trin. Gram. t.* 78. Head-waters of the Colorado.

POA ARANIFERA, *Torr. in Marcy's Rep. p.* 301. Head-waters of the Colorado; April 13. Also the var. *β.* With the preceding, and Big Springs of the Colorado.

FESTUCA TENELLA, *Willd. Enum.* 1, *p.* 116. High sandy plains northeast of the Pecos, and head-waters of the Colorado; March to April.

FESTUCA MACROSTACHYA, (n. sp.) On the Pecos. This is one of numerous Grama-grasses of Texas and New Mexico.

HORDEUM PUSILLUM, *Nutt. Gen.* 1, *p.* 87; *Kunth, Enum.* 1, *p.* 457. Sandy soil; Llano Estacado; March.

ELYMUS CANADENSIS, *Linn.; Kunth, Enum.* 1, *p.* 457. Near Fort Washita.

FILICES.

ADIANTUM CAPILLUS-VENERIS, *Linn.* Big Springs of the Colorado. We follow Hooker in uniting this and several other allied forms of Adiantum.

NOTHOCHLÆNA SINUATA, *Kaulf.* Between the Rio Grande and Llano Estacado.

GYMNOGRAMMA TARTAREA, *Desv.* With the preceding.

CHEILANTHES LINDHEIMERI, *Hook. Spec. Fil.* 2, *p.* 101, *t.* 107. Llano Estacado. This is the same as No. 2126 of Wright's New Mexican collection.

PTERIS (PLATYLOMA) ANDROMEDÆFOLIA, *Kaulf, Enum. Fil. p.* 188. Hueco Swamps, Texas. This is a common fern in California.

EXPLANATION OF THE PLATES.

Plate I. SELENIA DISSECTA. Page 160.

Fig. 1, a flower, moderately magnified; fig. 2, a sepal; fig. 3, a petal; fig. 4, the stamens; fig. 5, the young pod; fig. 6, the mature pod—all more magnified than fig. 1; fig. 7, seed, still more magnified; fig. 8, section of the same, equally magnified.

Plate II. CALYMMANDRA CANDIDA. Page 166.

Fig. 1, involucre and receptacle; fig. 2, chaff of the pistillate flowers; fig. 3, a pistillate flower; fig. 4, a perfect flower, partly enclosed in its woolly chaff; fig. 5, the same, without the chaff; fig. 6, chaff of the perfect flower; fig. 7, corolla of the perfect flower laid open—all moderately enlarged; fig. 8, a stamen, more magnified; fig. 9, upper portion of the style from a perfect flower, equally magnified; fig. 10, the same from a pistillate flower; fig. 11, achenium, pretty highly magnified; fig. 12, longitudinal section of the same.

Plate III. FILAGINOPSIS MULTICAULIS. Page 166.

Fig. 1, involucre and receptacle; figs. 2 and 3, paleæ of a pistillate flower; fig. 4, a pistillate flower; fig. 5, palea of a staminate flower; fig. 6, staminate flower; fig. 7, corolla of the same, laid open and showing the stamens; fig. 8, its abortive style; fig. 9, achenium; fig. 10, vertical section of the same—all the figures variously magnified.

Plate IV. STENANDRIUM BARBATUM. Page. 168.

Plate V. PENTSTEMON FENDLERI. Page 168.

Fig. 1, corolla laid open, and moderately enlarged; fig. 2, longitudinal section of a flower, more magnified; fig. 3, a perfect stamen, still more magnified; fig. 4, upper portion of the imperfect stamen; fig. 5, pistil, its ovary laid open vertically.

Plate VI. SALVIASTRUM TEXANUM. Page 169.

Fig. 1, vertical section of a flower; fig. 2, the calyx laid open; fig. 3, corolla; fig. 4, a stamen; fig. 5, pistil; fig. 6, vertical section of the ovary; fig. 8, vertical section of a seed—all the figures variously magnified.

Plate VII. STEGNOCARPUS CANESCENS. Page 169.

Fig. 1, a flower, enlarged; fig. 2, the corolla laid open, showing the stamens and pistil, equally magnified; fig. 3, a stamen, more magnified; fig. 4, pistil, with the ovary cut longitudinally; fig. 5, an ovule, highly magnified; fig. 6, the fructiferous calyx, moderately enlarged; fig. 7, cross-section of the fruit; fig. 8, a nutlet, more magnified; fig. 9, vertical section of the same.

Plate VIII. PTILOCALYX GREGGII. Page 170.

Fig. 1, a flower, magnified; fig. 2, the corolla laid open vertically; fig. 3, a stamen, more magnified; fig. 4, the pistil, equally magnified; fig. 5, an ovule, highly magnified; fig. 6, fructiferous calyx; fig. 7, the fruit and persistent style; fig. 8, transverse section of the fruit, showing one perfect cell containing a seed, and three abortive, collapsed cells; fig. 9, embryo—the last five figures moderately magnified.

Plate IX. EDDYA HISPIDISSIMA. Page 170.

Fig. 1, leaves, showing the upper and lower surface, magnified; fig. 2, a flower, equally magnified; fig. 3, the corolla laid open vertically; figs. 4 and 5, stamens, front and back views; fig. 6, pistil, with the ovary cut vertically; fi . 7, cross-section of the ovary; fig. 8, fructiferous calyx; fig. 9, a nutlet; fig. 10, embryo.

Plate X. PHACELIA POPEI. Page 172.

Fig. 1, flower enlarged; fig. 2, corolla laid open, showing the stamens and pistil; fig. 3, stamens, more magnified; fig. 4, calyx and pistil; fig. 5, pistil, with the ovary vertically divided; fig. 6, transverse section of the ovary; fig. 7, ovule, more magnified; fig. 8, fruit scarcely matured, with the persistent calyx; fig. 9, seed, more magnified; fig. 10, vertical view of a seed transversely divided; fig. 11, embryo, still more magnified.

INDEX.

A.

Page.

Alamos 11, 30
Alexander, Brevet Lt. Col 51
Altitude of stations above sea-level 105–107
Analyses of soils 95
Analyses of mineral waters 96–97
Apache Indians—
  General history of 13
  Possessions of 30
  Fight with Mexicans 53–54
  Resorts of 63
  Interview with 65
Apache Indians of the plains 17
Arapahoe Indians 17
Armijo, Gen., reign of 48
Artesian wells on the Llano Estacado—
  Practicability of 9, 35–37
  Estimated cost 37-38
  Benefits resulting from 38
Astronomical observations—
  Instruments used 2
  Tables of 112–156
Abronia 174
Acacia 164
Acanthaceæ 168
Acerates 173
Achillea 167
Aciphyllæa 167
Acleisanthes 174
Actinella 167
Actinomeris 167
Adiantum 177
Agassizia 167
Allium 176
Algarobia 164
Alyssineæ 160
Amblyolepis 167
Ammoselinum 165
Amorpha 162
Amsonia 173

Page.

Apocynaceæ 173
Apogon 167
Argemone 159
Artemisia 167
Asclepias 173
Asclepiadaceæ 173
Astragalus 163
Astrophyllum 161
Atriplex 173

B.

Baird, Prof. S. F.—
  Natural history collection submitted to 3
  Preliminary report on natural history 94
Big Mineral creek 93
Big Springs of the Colorado 72, 77, 78
Blake, W. P., reference to geological report of 41, 44, 99
Booth, Prof. Jas. C.—
  Soils analyzed by 3
  Report on soils and mineral waters 95–97
Botanical department—
  In charge of 3
  Nature of collection 3
  Specimens examined by 3
  Torrey & Gray's report 157–178
Boundary commission 2
Brazos river—
  Description of 9, 40
  Description and resources of its valley 9, 26–27, 88
Byrne, J. H.—
  Detail of 52
  Diary of expedition 51–93
Bahia 167
Batschia 171
Bellis 166
Berberidaceæ 159
Berberis 159
Berlandiera 166
Borageæ 171
Boraginaceæ 169

	Page.
Camanche Indians—	
History of population, &c	14–16
Position of	20
Interview with party of	81
Caves	59
Cherokee Indians	17
Cheyenne Indians	17
Chickasaw Indians	17
Choctaw Indians	17
Clear Fork of the Brazos	84, 85
Coal beds, valley of the Brazos	9, 40, 88
Colorado river and valley	27
Cornudos wells	11, 30
Cornudos mountain	55
Construction of railroad along the route—	
Recapitulation	45
Estimated cost	45
Suggestions	45
Table of ascents and descents	46
Cactaceæ	165
Calix	175
Callirrœ	160
Calophanes	168
Calymmandra	166, 177
Camassia	176
Campanula	168
Campanulaceæ	168
Carophyllaceæ	160
Cassia	163
Castilleja	169
Ceanothus	162
Celtis	175
Centaurea	167
Ceratochloa	176
Cercis	163
Cercocarpus	164
Cereus	165
Chærophyllum	165
Chætopappa	166
Cheilanthes	177
Chenopodina	173
Chenopodiaceæ	173
Chloris	176
Chthamalia	173
Chrysactinia	167
Cirsium	167
Cistaceæ	160
Clematis	159
Cnidoscolus	174
Comandra	175
Commelyna	176
Commelynaceæ	176
Compositæ	166
Coniferæ	175
Convolvulaceæ	172
Convolvulus	172
Coreopsis	167
Corydalis	159
Cruciferæ	159
Cryptantha	171
Cucurbita	164
Cucurbitaceæ	164
Cupuliferæ	175
Cympterus	165
Cynoglossum	171
Cyperaceæ	176

D.

Delaware creek, and valley of	29–30
Springs	11, 29, 97
Diary of Expedition, by J. H. Byrne	51–93
Object of	3
Diffenderfer, Dr. W. L.—	
Charge of botanical collection	3
Meteorological observations by	3
Detail of	52
Doña Ana	6
Dalea	163
Daucus	165
Delphinium	159
Desmanthus	164
Desmodium	163
Diplopappus	166
Dipteracanthus	168
Ditthyræa	159
Dodecatheon	168
Draba	160
Dracopis	166
Dysmicodon	168

E.

Elm fork of the Trinity	91
El Paso	32
"Emigrant Crossing"	69
Emory, Major, reference to opinion of	44
Expedition—	
Organization of	1, 51–52
Object of	4
Exploration, suggestion in relation to future	45–46
Echinacea	166
Echinocactus	165
Echinospermum	171
Eddya	170, 178
Ehretia	170
Eleocharis	176
Elymus	177
Ephedra	175
Engelmannia	166
Erigeron	166
Erigonum	174
Eritrichium	171
Erodium	161
Erysimum	159
Euphorbia	174, 175
Euphorbiaceæ	174
Evolvulus	172

F.

Page.

Fire on the prairie 61–62
Fish 62, 65
Fort Arbuckle 23
Fort Belknap 9, 22
Fort Bliss 24
Fort Chadbourne—
  Position of 22, 86
  Suggested change of 23
Fort Conrad 24
Fort Fillmore—
  Position 6
  Proposed removal of 23
Fort Gibson 23
Fort Smith 23
Fort Thorne 6, 24
Franklin 6, 32
Fuel.—(See Wood.)
Fallugia 164
Festuca 177
Filaginopsis 166, 177
Filices 177
Fumariaceæ 159

G.

Gainesville 92
Game 59, 60, 65
Garrard, Lieut. K.—
  Charge of barometrical determinations 2
  Detail of 52
  Proceeds in search of new route 57
  Success 58
  Instructions to, for exploring Guadalupe mountains 61–62
  Report of exploration of Guadalupe mountains .. 62–63
General summary 47
Geographical position of route, manner of determining 1
Geology—
  Plan of geological profiles 2
  In charge of 3
  Reference to report of W. P. Blake 41, 44, 99
  Note in reference to preliminary report of Jules Marcou 98
Grades—
  From Red river to Llano Estacado 40–41
  Llano Estacado 41–42
  Pecos to Rio Grande 42–45
  Average on route 45
  Table of 46
Grapes, cultivation of 33
Grass—
  Along the route 11–12, 98–99
  Between valley of Rio Grande and Pecos river .. 7, 8
  On line of 32d parallel 21
  Near head of Delaware creek 23
  On Jornada del Muerto 24
  Between Red river and Rio Grande 25
Graves 57
Guadalupe mountains 7, 63

Page.

Gypsum on Llano Estacado 28, 29, 58, 59
Gaillardia 167
Galium 166
Gaura 164
Gentianaceæ 173
Geraniaceæ 161
Geranium 161
Geum 164
Gilia 172
Gnaphalium 167
Gnolobus 173
Grama-grass 177
Gramineæ 176
Greggia 159
Grossulaceæ 165
Gymnogramma 177

H.

Henry, Dr., natural history collection by 94
  Hueco mountains 7, 52
  Hueco tanks 7, 11, 30
Helenium 167
Heliotropium 171
Hendecandea 174
Hoffmanseggia 163
Hordeum 177
Houstonia 166
Hydrophyllaceæ 172
Hymenatherum 167
Hymenopappus 167

I.

Indians—
  Apaches 13, 30, 53–54, 63, 65
  Apaches of the plains 17
  Arapahoes 17
  Caddoes 17
  Camanches 14–16, 20, 81
  Cherokees 17
  Cheyennes 17
  Chickasaws 17
  Choctaws 17
  Kiowas 16–17, 72, 77
  Lipans 14
  Tonkawas 17
  Utahs 16
  Wacoes 17
  Wichitas 17
Indian slavery 13
Independence springs 11, 30
Johnston, Col. J. E 2
Jornada del Muerto 6, 24
Isletta 6, 32
Jasminaceæ 173
Iridaceæ 176
Junaceæ 176
Juncus 176
Juniperus 175

K.

Page.

Kiowa Indians—
General history of 16–17
Meeting with parties of 72, 77
Krameria 162
Krigia 167

L.

Las Cruces 6, 31
Las Tortugas 6, 31
Latitudes—
Determination of 1
Table of 104
Lipan Indians 14
Llano Estacado—
Artesian wells on 9, 35–37
Description of 8–9, 66
Geological structure of 9, 36
Resources of 11, 28–29
Longitudes—
Determination of 1
Table of 104
Lower Cross Timbers 26, 92
Labiatæ 169
Larrea 161
Lechea 160
Leguminosæ 162
Lepidum 160
Lespedeza 163
Liliaceæ 176
Linaceæ 161
Linaria 168
Lindheimeria 166
Linum 161
Lithospermum 171
Lygodesmea 168

M.

Maguey plant, and manner of cooking 58
Magnetic declinations, table of 104
Maps, list and explanation of 2
Marcou, Jules, reference to report of, on geology of Llano Estacado 36
Marcy, Capt., reference to report of 9
Marshall, Lieut. L. H.—
Charge of natural history collection 3
Detail of 52
Instructions to, for examination of the Pecos river 64
Report of examination 64–65
Departure for Fort Chadbourne 82
Return 86
Massie, Mr. 93
Meteorological observations, kept by 3
table of 100–103
Mesilla 6, 31
Mesilla valley 6, 31, 32–33

Page.

Military posts—
Establishment of, in the Indian country 19–20
Objects and effect of 19–20
Present positions and proposed changes 22
(See Forts.)
Minerals 31, 67
Mineral springs 29–31
Mineral waters, report on analyses of 96–97
Molino 6, 33
Mustang springs 71, 97
Machaeranthera 166
Malvaceæ 160
Malvaltrum 161
Marshallia 167
Melampodium 166
Menodora 173
Mezquit 164
Microrhamnus 162
Mimosa 16
Monarda 169
Monardo 169
Morus 175
Myosotis 171
Myosurus 159

N.

Natural History—
Collections by 3, 94
Preliminary report 94
Table of species and specimens 94
Nariadaceæ 176
Nicotiana 173
Nothochlæna 177
Nothoscordum 176
Nyctaginaceæ 174

O.

Ojo del Cuerbo 11, 30, 55
Ojo de la San Martin 52
Ojo de la Soledad 52
Ojo del San Martin 58
Organization of party 1–4, 51–52
Organ mountains 7
Obione 173
Oenothera 164
Oldenlandia 166
Onagraceæ 164
Onosmodium 171
Opuntia 165
Oxalidaceæ 161
Oxalis 161
Oxybaphus 174
Oxytropis 163

P.

Pecos river and valley 8, 29, 56, 60, 66
Falls of 59–60
Profiles—
Determination of 2
In charge of 2

Page.

Profiles—
Instruments used in determination 2
Table of observations for determining from El Paso to Preston 108–110
Table of observations for determining from Emigrant Crossing of Pecos to Big Springs of the Colorado 111
Table of observations for determining through San Augustine Pass of the Organ mountains. 111
Panicum 176
Parietaria 175
Paronychia 160
Parthenium 166
Passaveraceæ 159
Passiflora 165
Passifloraceæ 165
Pectocarya 171
Pentalophus 171
Pentstemon 168, 169, 178
Perezia 167
Petalostemon 163
Phacelia 172, 178
Phalaris 176
Phlox 172
Physalis 173
Phytolacca 174
Phytolaccaceæ 174
Picradenia 167
Pinaropappus 160
Planera 175
Plantaginaceæ 168
Plantago 168
Poa 176
Polemoniaceæ 172
Potamogeton 176
Polygala 162
Polygalaceæ 162
Polygonaceæ 174
Polygonum 174
Polytaenia 165
Primulaceæ 168
Prosopis 163
Prunus 164
Pseudoscordum 176
Psoralea 163
Pteris 177
Ptilocalyx 170, 178
Pyrrhopappus 168

Q.

Quercus 175

R.

Red fork of the Colorado 85
Red river and valley 10, 25–26, 29
Rio Grande and valley 6, 31–34
Ranunculaceæ 159
Rhamnaceæ 162
Rhus 162
Ribes 165
Riddellia 167
Rosa 164
Rubiaceæ 166
Rubus 164
Rumex 174
Rosaceæ 164
Rutaceæ 161
Rutidocaryum 171
Rutosma 161

S.

Sacramento mountains 31
Sacramento river 65
San Elizario 6, 32
San Tomas village 6
Sanchez, chief of Camanches 81
Santa Fé trade 47–48
Sand-hills 69
Character of, on hills adjoining Llano Estacado. 9
Selection of route across the plains 21
Selenite 68
Settlement of Texas 48
Sierra de los Alamos 54
Simpson, Captain, reference to report of 9
Soils—
Plan of collecting 2
Submitted to 3
Preliminary report on 95–97
Analyses of 95–97
Springs—
Delaware 11, 29, 97
Independence 11, 30
Mineral 2–32
Mustang 71, 97
Ojo del Cuerbo 11, 30, 55
Ojo del San Martin 52
Ojo de la Solidad 52
Sulphur, of the Colorado 11, 78, 97
(See Tanks.)
Staked Plain.—(See Llano Estacado.)
Stem, Colonel Jefferson, Indian agent 86
Stone for building, near head of Delaware creek 23
Colorado valley 27
on Delaware creek 29
between Red river and Llano Estacado 40–41
Llano Estacado 41–42
between Pecos river and Rio Grande 42–45
Sulphur springs of the Colorado 11, 78, 97
Sabbatia 173
Salicaceæ 175
Salvia 169
Salviastrum 169, 178
Santalaceæ 175
Sapindaceæ 162
Sapindus 162
Schrankia 164
Scilla 176

Page.

Scirpus 176
Screw-bean 163
Screw-tree 163
Scrophulariaceæ 168
Scutellaria 169
Selenia 160, 177
Senecio 167
Sicydium 164
Silene 160
Simsia 166
Sisymbrium 159
Sisyrinchium 176
Smilaceæ 176
Smilax 176
Solanaceæ 172
Solanum 172
Solidago 166
Sophora 163
Sphæralcea 161
Stegnocarpus 169, 178
Stenandrium 168, 177
Stellingia 174
Streptanthus 159
Strombocarpa 163
Stylosanthes 163
Sueda 173

T.

Tables—
Cost, length, &c., of road 45
Ascents and descents 46
Natural history collection 94
Analyses of soils 95, 96, 97
Analyses of mineral waters 97
Camping places on line of survey 98–99
Meteorological observations 100–103
Latitude, longitude, and magnetic declinations .. 104
Altitude of stations above sea-level 105–107
Observations for determining profile from El Paso to Preston 108–110
Observations for determining profile from Emigrant Crossing of the Pecos to Big Springs of Colorado 111
Observations for determining profile through San Augustine Pass of the Organ mountains 111
Astronomical observations 112–156
Tanks—
Alamos 11, 30
Cornudos, or Thorne's wells 11, 30
Hueco 7, 11, 30
(See Springs.)
Taplin, Captain C. L.—
Charge of geological collection 3
Detail of 52
Instructions to for examining the Llano Estacado 60
Report 73
Terminus (eastern) of the road 49
Texas—
Grant of land by 50
Settlement of 48

Page.

Thorne's wells 30
Timber—
Between 32d and 34th parallels 5
32d parallel, near Guadalupe mountains 7, 8
Valley of the Pecos 8, 29
Valley of Red river 9, 24, 25
Valley of the Brazos 9, 26–27, 40, 88
Country drained by tributaries of Red river 10
Between Arkansas and Rio Grande valley 10
33d parallel 22
Colorado valley 22, 27, 28
East face of Guadalupe mountains 11, 44
West face of Guadalupe mountains 11
Trinity River valley 26
Llano Estacado 28, 41–42
Between Red river and base of Llano Estacado. 40–41
Between Pecos river and Rio Grande 42–45
(See Wood.)
Tonkawa Indians 17
Trinity river and valley 26
Tephrosia 162
Teucrium 169
Thelesperma 167
Tiquilia 171
Tornio 163
Townsendia 166
Tradescantia 176
Tragia 174
Tripsacum 176

U.

Upper Cross Timbers 26, 40, 90
Utah Indians 17
Umbelliferæ 165
Ungnadia 162
Urticaceæ 175

V.

Valerianaceæ 166
Verbena 169
Verbenaceæ 169
Veronica 168
Vesicaria 159, 160
Vicia 162
Vitaceæ 162
Vitia 162

W.

Waco Indians 17
Water—
Between 32d and 34th parallels 5
Between valley of Rio Grande and Red river ... 6
Between valley of Rio Grande and Pecos river. 6, 42–45
Between Arkansas and Rio Grande valley 10
Along the route 11–12, 21, 98–99
In Llano Estacado 11, 21, 28–29, 35–38
Route from La Vaca bay to Doña Ana 23
Valley of Delaware creek 23, 29–30
Jornada del Muerto 24
Between Red river and Llano Estacado 40–41

	Page.
Water—	
Report and analyses of mineral waters	96–97
(See Tanks and Springs.)	
West fork of the Trinity	88
White mountains	31
Wichita Indians	17
Wine, manufacture of	33
Wood—	
Along the route	11–12, 98–99
Between valley of Rio Grande and Pecos	7, 8, 42, 45
Between Rio Grande and Guadalupe mountains	7
Between Guadalupe mountains and Pecos river	7
Cerro Alto	11
Sierra de los Alamos	11
Los Cornudos	11
Ojo del Cuerbo	11
Guadalupe mountains	11, 23
Delaware creek	11
Llano Estacado	11, 12, 28, 29, 41, 42
Sulphur springs, Colorado	11
Colorado river	12, 22, 27, 28
Clear fork of Brazos	12

	Page.
Wood—	
Brazos river	12
Red river	12
Line of 32d parallel	21
Jornada del Muerto	24
Pecos river	29
Between Red river and Llano Estacado	40–41
(See Timber.)	
Wild china	162
X.	
Xanthisma	166
Y.	
Yerba del Gato	174
Yucca	176
Z.	
Zanthoxylum	161
Zinnia	166
Zizyphus	162
Zygophyllaceæ	161

EXPLANATORY NOTE TO GEOLOGICAL REPORT.

WASHINGTON, *February* 18, 1857.

The mineralogical collections made by me were placed in the hands of M. Jules Marcou for examination, and carried by him to France. They were subsequently returned in a confused condition, and with many of the labels displaced. This fact will account for many errors in the report, map, and section prepared by Mr. Blake.

JOHN POPE,
Captain Topographical Engineers.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

ROUTE NEAR THE THIRTY-SECOND PARALLEL, FROM THE RED RIVER TO THE RIO GRANDE,

EXPLORED BY BVT. CAPT. JOHN POPE, TOP. ENGINEERS, IN 1854.

REPORT

ON

THE GEOLOGY OF THE ROUTE,

NEAR THE THIRTY-SECOND PARALLEL:

PREPARED FROM THE COLLECTION AND NOTES OF CAPT. POPE,

BY

WILLIAM P. BLAKE,

GEOLOGIST OF THE OFFICE OF THE UNITED STATES PACIFIC RAILROAD SURVEYS.

WASHINGTON, D. C.

1856.

WASHINGTON, D. C., *December,* 1855.

SIR: I herewith submit some observations upon the geology of the region explored by Captain Pope, near the 32d parallel, in 1854, based upon the collection of rocks and fossils which were placed in my hands by you for description.

This collection of rocks, taken from various points along the route, is very interesting and complete, and doubtless presents a fair view of the mineral characters of the formations. A list of the collection, and descriptions of the most important specimens, will be found in this report. The fossils, although not numerous, are from interesting localities; but there are no species which have not been previously described and figured.

I have made free use of the descriptions of the main features of the country contained in Captain Pope's report; and in the absence of all geological sections, I have been guided by the topographical and general descriptions in assigning the boundaries of the different formations.

Respectfully, yours,

WILLIAM P. BLAKE,

Geologist of the Office of the U. S. Pacific Railroad Explorations and Surveys.

Captain A. A. HUMPHREYS,

U. S. Topographical Engineers, in charge of the Office of U. S. Pacific Railroad Explorations and Surveys.

CONTENTS.

CHAPTER I.

GENERAL REMARKS ON THE PHYSICAL GEOGRAPHY OF THE REGION EXPLORED.

Page.

Extent and boundaries of the region.—Mountain ranges.—Trend and elevation.—Table lands, their extent and elevation.—Llano Estacado.—Two slopes of the plain.—Altitude.—Bluff character of its northern borders.—Limit of the Llano on the east ..... 7—11

CHAPTER II.

GEOLOGY OF THE MOUNTAIN RANGES.

Ranges probably granitic, with Carboniferous limestone.—Organ mountains.—Hueco mountains.—Los Cornudos.—Polished rocks.—Guadalupe mountains.—Trend towards the Witchita mountains.—Sierra de los Alamos and Los Cornudos.—Probable shallowness of the valleys in the granite.—Natural tanks or reservoirs of water.—Similar tanks in the African deserts.—Probable origin ..... 12—15

CHAPTER III.

GEOLOGY OF THE LLANO ESTACADO AND THE PLATEAUX BETWEEN THE MOUNTAIN RANGES FROM THE RIO GRANDE TO THE COLORADO.

Horizontal character of the strata of the Llano.—Section of the strata.—Absence of bluffs.—Character of the strata underlying the Llano.—Gypsum and red clays.—Probable Cretaceous age of the upper strata of the Llano.—Fossils.—Cretaceous at Doña Ana.—Possible presence of Tertiary strata.—Absence of Jurassic fossils.—Red sandstone and Gypsum formation of Delaware creek and the Pecos.—Gypsum of the Andes and of Iowa.—Of Nova Scotia and Virginia.—Of Tuscany, Italy.—Extent of the American formation.—Geology of the plains between the Rio Grande and the Guadalupe mountains.—Sand-hills.—Saline lakes.—Springs.—Artesian wells 16—23

CHAPTER IV.

REMARKS ON THE GEOLOGY OF THE ROUTE, FROM THE LLANO ESTACADO TO PRESTON.

General description of the country.—Red sandstone and gypsum.—Age of the Gypsum formation.—Absence of fossils.—Probable Cretaceous or Carboniferous age.—Gypsum of Nova Scotia in the Carboniferous.—Fort Belknap to Preston.—Section of strata at Belknap.—Coal.—Carboniferous limestone.—Cross timbers.—Cretaceous.—Loess ..... 24—28

CHAPTER V.

BUILDING-STONE.—COAL.—GYPSUM.—LEAD.—SULPHUR.

1. Building-stone.—Description of the principal specimens in the collection.—Remarks upon them and their distribution ..... 29—30
2. Coal.—Fort Belknap.—Carboniferous formation.—Lignite on the Brazos.—Probable extent of the coal ..... 31—32
3. Gypsum.—General description of the mineral.—Its composition and uses.—Anhydrite.—Varieties of gypsum in the collection.—Description of a specimen containing carbonate of lime.—Gypsum of Plaister Cove, N. S.—Applications of gypsum in the arts.—Quantity mined and shipped to the United States.—Remarks on the origin and formation of the beds.—Gypsum in the Tertiary strata of California ..... 32—36
4. Lead.—Lead and silver mines of the Organ mountains.—Description of the specimens.—Galena.—Cerusite ... 36—38
5. Sulphur.—Analysis of a dry powder from Delaware creek 38

CHAPTER VI.

DESCRIPTION OF THE FOSSILS COLLECTED BY CAPTAIN JOHN POPE.

Page.
Exogyra.—Gryphæa.—Productus.—Remarks in conclusion ..... 39—40

CATALOGUE OF THE GEOLOGICAL COLLECTION.

1. Rocks and minerals.—2. Fossils ..... 41—42

NOTE IN EXPLANATION OF THE MAP AND SECTION.

INDEX ..... 45—47

ILLUSTRATIONS.

GEOLOGICAL MAP OF THE ROUTE.

GEOLOGICAL SECTION FROM PRESTON TO THE RIO GRANDE, NEAR EL PASO.

REPORT.

CHAPTER I.

General Remarks on the Physical Geography of the region explored.

Extent and boundaries of the region.—Mountain ranges.—Trend and elevation.—Table-lands, their extent and elevation.—Llano Estacado.—Two slopes of the plain.—Altitude.—Bluff character of its northern borders.—Limit of the Llano on the east.

THE strip of country explored by Captain Pope, extending from Preston, on the Red river of Texas, in a direction south of west, to the Pecos river, and thence nearly west to the valley of the Rio Grande at El Paso and Doña Ana in New Mexico, embraces within its limits geological formations of great variety and interest. Its western end is crossed by the ranges of the great central mountain chain of the continent; its eastern reaches to the comparatively low plains of the Red river; while the central portion of the route is upon the extended and elevated desert plain of the Llano Estacado.

As it is very desirable and interesting to note the connexion of the geology with the prominent physical features of the region, I purpose to precede the more particular geological descriptions by some general remarks, based upon the observations of the survey, and which are given in the profile of the route.

The physical features of the region, though strongly marked, are very simple. On the west, the mountain ranges break the monotony of the plains, and form, by their numbers and parallelism, a series of longitudinal valleys extending nearly north and south; but to the eastward of these, and over the greater part of the country Captain Pope traversed, an almost unbroken horizontal plain is found.

These mountain ranges are three in number, and are there known by the following names: Organ mountains, Hueco mountains, and Guadalupe mountains. The prolongations of these ranges towards the north at Albuquerque and Santa Fé have other and local names—Sacramento mountains, Sierra Blanco, &c.; but the whole series form a part of the main central chain, known in its northern portions as the Rocky mountains. The general direction or trend of the Organ mountains and the Hueco mountains is north and south—the former deflecting slightly towards the west. The Guadalupe range, however, does not conform to this direction, but diverges and trends towards the east; its mean direction, as it is given upon Captain Pope's map, being N. 38° E. According to the report of Lieutenant Garrard[1], this range extends southeasterly for seventy or eighty miles beyond the high peak, becoming more impassable as you proceed southward, and finally uniting with a chain of mountains having a northwest and southeast trend. The point which has generally been considered as the termination of the range, he found to be a spur running out into the Salt Plain. The northern terminus, according to Captain Pope's observations, is about sixty miles north of the 32d parallel, where it

[1] Report of Captain Pope, page 63.

sinks into the valley of the Pecos. I do not find an estimate of the general elevation of the range, but the summit of the Guadalupe Pass, one of the lowest, was found to be 5,717 feet above the sea;[1] while the Hueco Pass is 4,811 feet; and the pass in the Organ mountains, between Doña Ana and San Augustin spring, is 5,467. In fact, the Guadalupe Pass is the highest point Captain Pope reached on his whole line. It is important to note here, that the Witchita mountains, explored by Captain Marcy and Doctor Shumard, and found to be of granite, are located directly in the line of trend of the Guadalupe mountains, and their geological connexion is thus indicated. The outcrop is, however, very distant; but other knobs of granite in a line with, or parallel to, the Witchita mountains, indicate that the general trend of the granitic axes or elevations of that region is N. E. and S. W.; and this favors the supposition of the prolongation or connexion of the Guadalupe chain with the Witchita. We should thus expect to find either more outcrops of granite between the end of the Guadalupe and the Witchita mountains, or a very perceptible modification of the surface of the Llano.

The intervals between the mountain ranges, which are crossed by the line of survey, being occupied by high table-lands, the altitude of these ranges above the surrounding surface is not great. Captain Pope has described three table-lands, rising one above the other towards the east; their greatest width being at the northeast, and their inclination being very gentle towards the southeast; while on the west they terminate in abrupt descents, the three mountain ranges just described forming their western limits. Two of these table-lands are west of the Guadalupe mountains, and are comparatively narrow; the first, from the Rio Grande to the Hueco mountains, being 25 miles; and the second, from the Hueco mountains to the Guadalupe Pass, being about 80 miles in width. The average elevation of the first, deduced from Captain Pope's numerous observations for altitude, is 3,963 feet, being the mean of 12 determinations at distant points. This plain must be remarkably level, and well deserves the title of *Mesa*, which it receives; for the greatest difference in altitude between the 12 stations, from the summit or edge of the plain to the Hueco mountains, is only 56 feet; the highest station being 3,991 feet, and the lowest 3,935. The second plain is more elevated; and yet its lowest point, at the Ojo del Cuerbo, (3,893 feet above the sea,) is lower than any recorded on the first, and is, at its eastern side, near the Guadalupe mountains. The slope of the plain, from the summit of the pass eastward, appears to be very gradual, and, with one or two exceptions, is remarkably regular. One of these exceptions is at the base of the Sierra de los Alamos, which consist of isolated mountains rising above the general level of the plain. The mean altitude of this plain on that line, according to the measurement of the survey, may be considered as 4,250 feet.

The western limit of this plain is the range of the Guadalupe mountains, and beyond them, to the east, is the broad area of table-lands and semi-deserts, reaching to the Cross Timbers of Texas. We here find the great Llano Estacado, or Staked Plain, an elevated treeless waste, 125 miles in width, on the line of Captain Pope's survey. The observations for altitude show that this plateau is remarkably level, and is unbroken by hills or sudden undulations of the surface. The profile shows one great swell of the surface between the Pecos and the Colorado, forming two long, but very gentle slopes, similar to the slopes and counter-slopes of mountains and continents; that on the east being 130 miles in length, while on the west it is only about eighteen miles. The two extremes of this undulation at the beds of the rivers appear to have nearly the same elevation—about 4,000 feet; and the highest point between them—the "summit" of the Llano, as it is called by Captain Pope—is 4,706 feet. From Captain Pope's observations of the general bluff character of all the plateaux towards the west, and the consideration of the topography of the country further north, I have been disposed to regard this shorter or western slope as resulting from the erosion of the river Pecos, and to consider the gradual slope eastward from the summit as formerly continuous up to the base of the Guadalupe mountains, forming a uniform slope, similar to the two further west, which have been before described. It is, however, possible that this great undulation of the Llano, represented in the

[1] The elevation of this Pass is reported by Mr. A. B. Gray to be 4,897 feet. [Railroad Record, No. 136, Oct. 1855, p. 27.]

profile, is not caused by erosion alone, but that a gentle curvature of the strata exists in consequence of the presence of a line of elevation in the older rocks parallel with the Guadalupe range. Such a line of elevation, although far beneath the surface, is very probable; and the extended and gradual, but decided, elevation shown in the surface of the Llano, if it be not due entirely to the denudation and erosion of the Rio Pecos, favors the supposition. Such a line of elevation would produce a basin-shaped or trough-like disposition of the upper strata, even if they rested undisturbed, as originally deposited; and thus the conditions necessary to the success of artesian wells would be obtained.

The mean altitude or general elevation of the great plateau of the Llano has never yet been given. The numerous measurements of the survey, however, furnish the means of determining this elevation, at least for that portion along the route near the parallel of 32°. If we take the mean of the altitudes of 22 stations, from two to seven miles apart, between the Pecos, at the mouth of Delaware creek, and the Sulphur springs of the Colorado, we obtain, in round numbers, 4,500 feet as the mean altitude of the Llano along the line explored. A consideration of the courses of the rivers—the Pecos, Colorado, and Brazos—and the observations concerning the slope of the Llano, lead to the conclusion that the surface rises towards the north and northwest; or, in other words, that the Llano is highest in the northwestern portions, and descends gently, not only east, but southeasterly, towards the Gulf of Mexico. The sources of the Pecos river, at Hurrah creek, according to the observations of Lieutenant Whipple, who passed along the Canadian river, near the parallel of 35°, are at an altitude of about 5,000 feet; and this is over 200 miles north of the point at which Captain Pope crossed the stream. His observations upon the altitude of a portion of the Llano, between Amarillo and Rocky Dell creek, (longitude 102° 30′,) range from 4,128 to 4,400 feet; while the observations of the altitude of the summit, on the 32d parallel, almost directly south of that point, shows a height of 4,700 feet. These results are not consistent with the conclusion of the descent of the surface of the plain from the north to the south.

The formation of the Llano Estacado is one of the most marked physical features of the American continent. Its surface, rising over a broad area to an altitude, in almost every part, of over 4,000 feet, at the lowest estimate, and but little broken or traversed by river valleys, constitutes one of the most perfect examples of an elevated plateau, or *mesa*, that is found. The Great Basin, although generally supposed to be the broadest and most extensive plateau of the country, is entirely different in its character, being formed, not of extended and horizontal layers of rock, but of the *débris* and wash from the thousand mountains and ranges that rise at intervals from its surface, and only by their intersecting slopes produce that general elevation of the surface which has been regarded as a plateau. The Llano, on the contrary, is not broken by a single peak; and there is nothing to break the monotonous desert character of its surface, except an occasional river gorge or cañon, invisible from a distance, and often apparent only when the traveller stands on its brink.

According to the observations of Lieutenant Whipple, this great plateau continues beyond the valley of the Canadian far to the northward, and, although much cut and denuded by rivers, the table-like hills, with mural faces seen on all sides, show its former continuity. The borders of the plateau at the northward, along the Canadian and Red rivers, are well defined by a long line of vertical bluffs, rising like walls above the general level of the bordering country or river valleys. These are described by Captain Marcy in his report,[1] and were seen by Lieutenant Whipple as he approached the Llano from the east. Captain Pope has, however, ascertained that along the line of his survey this characteristic of the plain at the north is absent, and that, instead of a mural face on the west and east, the ascent from the level of the Pecos is very gentle, and "the summit-level was attained at a distance of thirty-five miles, without an abrupt ascent at any point, and without the appearance of any of the marked characteristics which had

[1] Exploration of the Red river of Louisiana, by Captains Marcy and McClellan, U. S. A. [Ex. Doc., 33d Cong., 1st sess.: Washington, 1854.]

been attributed to it. The descent from its summit to the headwaters of the Colorado was so gentle as only to be perceptible to instrumental survey; and there was nothing to mark its eastern limit, except the existence of the tributaries of that stream. Neither bluff nor uncommon swell of the ground marks its existence as you approach from the east or west, nor is its uniformity of surface disturbed at any point between the Pecos and the Colorado."[1] These observations are exceedingly interesting, and of importance to the question of the location of a railroad. It is possible, however, that this gentle inclination or descent from the surface of the Llano, both on the east and west, is local, and caused by peculiar erosions or degradation of the plain at those points. The Colorado river, at the eastern border of the plain, has numerous affluents; and it is to their continued wearing action that we may look for the destruction of the abrupt precipices which mark the Llano at other places. The regular swell of the Llano, as exhibited on Capt. Pope's profile, may thus result entirely from extensive lateral erosions along that portion of the Pecos, and not be due to the presence of a subterranean ridge of older rocks, as has been suggested.

According to the profile which Captain Pope has presented, the elevated plain of the Llano may be considered to extend from the Guadalupe mountains, or the Pecos, to a point beyond the Colorado, or the divide between it and the Brazos river. This point is 4,236 feet in altitude, and from it the surface descends very regularly for nearly 275 miles, to the banks of Red river, at the termination of the line of survey, only 641 feet above the tide-level.

In the descriptions by Captain Pope, however, he regards the sources of the Colorado, or the Sulphur springs, as the eastern limit of the Llano; and the character of the country indicates a change in the nature of the rocks and soil. I have, therefore, concluded that the geological formation composing the surface of the Llano does not extend on the line of the trail to the east of the Sulphur springs, and I have so represented it upon the geological map.

Rivers and streams.—The principal streams which traverse or take their rise in the Llano, are the Canadian and Red rivers, the Brazos and Colorado, and the Pecos. The first named flows from its sources in the mountains near Santa Fé, almost directly east, and intersects the Llano; the Pecos, also rising in the same place, flows not across the plain, but southerly, parallel with the mountain ranges, forming a long valley of erosion. The other rivers appear to rise near the eastern margin of the plain, and are formed by the union of numerous minor affluents, after they emerge from the cañons of the plateau. With very few exceptions, wherever these streams traverse or intersect the Llano, they are characterized by bold, bluff banks or walls, on either side, which are almost impassable, and confine the traveller to the tortuous course of the stream; while, above, the level surface of the plain stretches out and affords a boundless prospect in every direction. The vertical banks near the sources of Red river are graphically described by Captain Marcy in his report, as follows: "The gigantic escarpments of sandstone, rising to the giddy height of 800 feet on each side, gradually closed in until they were only a few yards apart, and finally united overhead, leaving a long, narrow corridor beneath, at the base of which the head spring of the principal branch of Red river takes its rise." * * * * "The stupendous escarpments of solid rock rising precipitously from the bed of the river to such a height as for a great portion of the day to exclude the rays of the sun, were worn away by the lapse of time, and the action of the water and the weather, into the most fantastic forms, that required but little effort of the imagination to convert into works of art, and all united in forming one of the grandest and most picturesque scenes that can be imagined." * * * * "Occasionally might be seen a good representation of the towering walls of a castle of the feudal ages, with its giddy battlements pierced with loop-holes, and its projecting watch-towers standing out in bold relief upon the azure ground of the pure and transparent sky above. In other places, our fancy would metamorphose the escarpments into a bastion front, as perfectly modelled and constructed as if it had been a production of the genius of a Vauban, with redoubts and salient angles all arranged in due order."[2]

[1] Report of Captain Pope, p. 9. [2] Exploration of the Red river by Captain Marcy. [33d Cong., 1st sess., pp. 55, 56.]

The region embraced in Captain Pope's explorations is thus divisible into three portions, differing very considerably in their physical configuration. We have, first, the mountain ranges, with their intervening plateaux, extending from the valley of the Rio Grande to the Pecos; secondly, the elevated plateau of the Llano Estacado, from the Pecos to the Sulphur springs of the Colorado; and, thirdly, the descent or slope from this plain over the undulating and fertile valleys of the Texan rivers to the Red river at Preston.

CHAPTER II.

Geology of the Mountain Ranges.

Ranges probably granitic with Carboniferous limestone.—Organ mountains.—Hueco mountains.—Los Cornudos.—Polished rocks.—Guadalupe mountains.—Trend towards the Witchita mountains.—Sierra de los Alamos and Los Cornudos.—Probable shallowness of the valleys in the granite.—Natural tanks or reservoirs of water.—Similar tanks in the African deserts.—Probable origin.

I DO not find many specimens from the mountain ranges in the collection, and their geological characters along the route are, therefore, not very fully represented. These ranges are the southern continuations of those bordering the valley of the Rio Grande, opposite Albuquerque and Santa Fé, and which are known to be composed chiefly of granite and gneiss, with overlying Carboniferous limestone bearing the usual fossils. The observations of the gentlemen connected with the United States and Mexican boundary commission at the south of the Guadalupe Pass, have shown that the southern prolongation of the chain, from which the Guadalupe range diverges, is composed chiefly of granitic rocks; the presence of Carboniferous limestone and eruptive rocks has also been shown at the southern end of the Organ mountains, near El Paso and Fort Bliss.

Organ mountains.—I do not find many recorded observations upon the rocks which compose the Organ mountains, or the *Sierra de los Organos*—so called, it is said, from the fancied resemblance of the highest peaks to the pipes of an organ. Captain Marcy states that they are of Trap formation, and somewhat columnar in structure, with the columns standing vertically, and in some cases rising to the height of a thousand feet, and terminating in sharp points.[1]

The southern part of this range is, however, known to be granitic, and to be partly composed of Carboniferous limestone, which, perhaps, presents mural faces; and these, seen from a distance, might be mistaken for bluffs of trappean rock. There are two small specimens of a dark-blue limestone from the Organ mountains in the collection, and they are evidently fossiliferous. They resemble specimens of the Carboniferous or Mountain limestone, to which formation they may be safely referred.

Hueco mountains.—The specimens which Captain Pope brought in from the Hueco mountains show that they are composed of granite; and if the great mass of rock is like the specimens, it is fine-grained and compact, and probably eruptive, not formed by the alteration of stratified rocks. It is, however, possible, and very probable, that the rocks usually called *metamorphic* are present in that range, and the presence of a small mass of white crystalline limestone with the specimens may be regarded as an indication of them. In the Diary of Mr. Byrne, I find it stated that the Hueco mountains at the tanks "are composed of a dark-grey sandstone scattered about in high masses, in the most grotesque disorder and confusion."[2]

I find very nearly the same observation made in the report of Captain Marcy, who traversed the range in 1849. He writes: "The road passes between the two mountains, which approach within a few rods of each other, leaving a level pass, bordered by immense ledges of rocks standing out in bold relief directly over the road. The rocks composing the mountains are

[1] Report on the Route from Fort Smith to Santa Fé, p. 198.

[2] Report of Captain Pope, Appendix A—Diary of J. H. Byrne, p. 53.

large masses of dark-grey sandstone thrown up in the utmost disorder and confusion, having numerous holes and caverns which have often served the Apaches as hiding-places."[1]

It is not impossible that these dark-grey blocks, although resembling sandstone, were the compact and fine-grained granite just described, or possibly Carboniferous limestone. Mr. Byrne afterwards states that the natural wells of the Cornudos were, as at the Hueco tanks, reservoirs in the rock, which was similarly piled up in confusion and disorder. He also states that these rocks are of a kind of granite or gneiss. Mr. Bartlett, the former boundary commissioner, who examined the Hueco mountains carefully, found them to be composed chiefly of granite. He says: "The formation here is granite in place, rising from 100 to 150 feet above the surrounding plain, and covered with large boulders piled up in every imaginable form. In many places, the rock projects or overhangs; and in others, frightful chasms, as though rent asunder by some violent concussion, appear."[2] At other places he found the deep, circular holes in the rock, made by Indians in pounding their corn; and these were in granite, and from twelve to fifteen inches deep. Such holes as these are exceedingly common in California, and are always in the most compact granite, as, undoubtedly, any granular rock like sandstone would be constantly abraded and fill the meal with grit. The descriptions which Mr. Bartlett gives of the overhanging rocks with their broad, flat surfaces, upon which many inscriptions have been made, indicate the presence of stratified rocks, although it is not at all improbable that such surfaces are presented by the masses of granite. When travelling through the Hueco Pass, however, Mr. Bartlett mentions the occurrence of grey limestone, which rose up on each side of the way like walls. At the same time, the great mountain could be seen half a mile beyond, with perpendicular sides of granite.

From these facts, and other evidences, I conclude that the Hueco mountains are principally granitic and metamorphic, and that stratified rocks occur on the flanks of the range; whether these are the Carboniferous strata, or not, it is of course impossible to decide without specimens and fossils.[3]

The peculiar broken character of this granite, the masses being of great size, and lying piled together in confusion, has resulted from the gradual breaking up of the mass *in situ*, and not from the action of floods, by which the blocks have been transported like boulders to their present positions. It is probable that the whole mountain is traversed by fissures in several directions, so that the whole rock is, in a manner, cut up into blocks, which become loosened and detached by weathering, and roll down its sides, accumulating in rude piles around the base of the cliffs.

Los Cornudos.—According to Mr. Byrne, this mountain is about five hundred feet high, and consists of huge masses of rock, scattered about in the utmost disorder and confusion. It was also his opinion, as has already been stated, that they were composed of a kind of granite or gneiss. I find the following observations on this rocky elevation in the narrative of Mr. Bartlett: "This wonderful mountain, of which it is impossible to convey any adequate idea by description, is a pile of red granite boulders of gigantic size, thrown up abruptly into the plain. The boulders are mostly of an oblong shape, with their largest diameter vertical; they are rounded, and often highly polished."[4] It is evident that, in respect to the broken, loose character of the rock, it much resembles that of the Hueco mountains at the wells, and, like it, appears to be a quantity of boulders piled together. This, as I have shown, arises from the decomposition of the rock, and its gradual breaking up along lines of fissure or of cleavage. Mr. Bartlett's description will apply very truthfully to an erupted rock somewhat basaltiform; and I am inclined so to regard it. Moreover, I find in the collection one specimen from this locality—No. 73 of the catalogue and description. The label states that it was taken from the

[1] Report on the Route from Fort Smith to Santa Fé, p. 199.

[2] J. R. Bartlett, Personal Narrative, i, p. 170.

[3] Lieutenant Bryan states that the rocks on each side of a part of this pass are in regular layers, and consist of limestone and granite. [Reconnaissances in New Mexico and Texas, p. 23.]

[4] J. R. Bartlett, Personal Narrative, i, p. 129.

vicinity of Los Cornudos, (Thorne's wells.) It is a peculiar porphyritic rock, of a light-grey color, with a faint shade of lilac. It is evidently eruptive, and may be called trachyte, the feldspar being in glassy crystals, and apparently imbedded in a less crystalline base of the same mineral. Hornblende is present in small black crystals, and a small hexagonal plate of dark-red mica is also visible. It is entirely different from the granite found at the Hueco mountains, and its characters are more nearly like those of recent erupted rocks, such as occur in dykes, and not in broad, extensive masses.

Mr. Bartlett noticed a peculiarly polished surface on all the rocks of that locality; in one place, it was so distinct that it appeared "to have been done by the hand of man." (p. 130.) This phenomenon was again presented near the Hueco tanks, where are some isolated granite precipices standing alone in the plain; the surface was so highly polished, that Mr. Bartlett remarked it particularly, and says that they were as smooth "as if they had been submitted to some artificial process. It was probably the effect of their exposure for ages to the weather."[1] I have very little doubt that this peculiar polished condition of the surface is precisely like that of the rocks on and around the Colorado desert of California. There, the rocks, as I have shown in a recent report,[2] receive their smoothness and high polish by the long-continued action of the grains of sand and of dust which are carried over their surfaces with velocity and force by the winds. This is probably the cause of the polished surface of the rocks of the mountains under consideration. On the desert, the climate is such that there is little or no perceptible disintegration of the rock, even after ages of exposure. This is peculiarly favorable to the production of the polished surface; for the cause is continually acting, and there are no opposing influences.

Guadalupe mountains.—The specimens from the Guadalupe mountains are all of limestone and sandstone, and I do not find any of the erupted rocks represented. From the general topographical indications, I am led to regard this range as having a granitic axis, or as being on the crest of an uplift of granite and the allied rocks, although they may not appear upon the surface. The specimens (particularly Nos. 5 and 6, see catalogue and description,)[3] are, however, of stratified rocks; and in the absence of any evidence of the presence of the Plutonic rocks, I have not represented them upon the map or section at the point crossed by the trail. The peculiar divergence of the mountains towards the northeast, and their apparent prolongation in the Witchita mountains, which has already been noticed, and the connexion of the range on the south with a range known to be granitic, together with its great elevation and rugged character, lead me to consider it highly probable that granite will ultimately be found in some parts of the range, north or south of the part explored. Although there are no fossils in the specimens of limestone from the Guadalupe, and thus there is no evidence of the age of the rocks, I cannot but regard them as Carboniferous, and I nave colored the range near the trail accordingly.

This opinion is strengthened by the following description, by Col. A. B. Gray, of the Guadalupe peak, which rises on the north side of the Pass: "There is an abrupt and precipitous cliff of columnar rock upon vast limestone terraces, attaining a height of 1,000 to 1,500 feet above its base, with a general elevation of several thousand feet above the plain. It can be seen at a great distance, owing to the clear and rarified atmosphere of the country. The face of this stupendous structure is perpendicular, and looks as if it had been shaped by some sudden and powerful convulsion of nature into the form of a large edifice or church, from which we gave it the name of Cathedral rock. Viewed from the deep gorge below, it is truly sublime and beautiful; its lofty peak towering to so great an altitude, and crowning the terminal point of an extensive range of mountains."[4] Messrs. Bartlett and Marcy give similar descriptions of this locality, and there is little or no doubt of the stratified character of the mountains.

[1] Bartlett, p. 175.

[2] Preliminary Geological Report in connexion with the report of Lieut. R. S. Williamson. See also the final report.

[3] For a description of these specimens, see a subsequent portion of this report.

[4] Report of A. B. Gray. [Railroad Record: Cin., October, 1855, vol. iii, whole No. 136, p. 13.]

The plain between the Hueco and the Guadalupe mountains is broken by several short ridges or isolated mountains of moderate height, and shown on the map under the names of *Sierra de los Alamos*, *Sierra Alto*, and *Los Cornudos*. As these mountains are probably all granitic, we may conclude that the foundation of granitic rock, or its subterranean surface, is not far from the surface of the plain; or, in other words, that the valleys in the granite are comparatively shallow, and that there is not a very great thickness of stratified or palæozoic formations resting in them. The topography and the probable Carboniferous strata of the Guadalupe mountains lead me to consider this highly probable, and to regard the country between the two ranges—the Hueco and Guadalupe ranges—as a broad axis or summit of granite and metamorphic rocks overlaid by sedimentary accumulations, similar to those of the Llano Estacado.

Natural tanks or reservoirs of water.—The natural tanks or wells which were visited are an interesting and peculiar feature, and seem to be placed in those desert plains for the comfort of the traveller. These tanks are found principally in the Hueco mountains, but occur at Los Cornudos and other similar localities. The tank in the Hueco mountains, near the trail, is described by Mr. Bartlett as a great cavity in the rock, containing about fifty barrels of pure, sweet water. This cavity was covered by a huge boulder weighing some hundred tons, and its lower surface was only four or five feet above the water.[1]

It is difficult to understand by what action the rocks, if of granite, were symmetrically hollowed out so as to form these well-like reservoirs. It would seem, from some of the descriptions, that they were in sedimentary rocks or strata of sandstone; and, if so, decomposition may have been the principal cause of their formation. Large cavities and irregularly-formed depressions are very common on the surface of granite—and probably this is the character of the tanks—the water being overshadowed and preserved from rapid evaporation by piles of rocky *débris*. Mr. Byrne states in his Journal that the water is not found in the tanks alone, but that there are numerous holes and crevices in the mountains, which contain enough for the use of travellers. This would indicate that the water collects in the irregular depressions of the rock, and not in holes worn out by the action of running water.

Similar reservoirs of water were found in the mountains of the African deserts by Bayard Taylor, who describes one in the Beyooda desert, as a vast natural hollow in the porphyry rock, in the centre of a basin or valley near the top of the mountain. "The water is held in a tank; it is from twenty to thirty feet deep, and as clear as crystal. The taste is deliciously pure and fresh."[2]

It is very probable that some of these reservoirs are constantly fed by the condensation of moisture upon the surrounding rocky summits; and others may be springs supplied through fissures in the rock, the evaporation from the surface being so rapid as to prevent their overflow. A great quantity of water is derived from the melting of snow which falls on these mountains and on the surrounding plains in the winter season.

[1] Bartlett, Personal Narrative, i, p. 134.

[2] Journey to Central Africa, &c., by Bayard Taylor, p. 414, 10th edit.: New York, 1854.

CHAPTER III.

Geology of the Llano Estacado and the Plateaux between the Mountain Ranges, from the Rio Grande to the Colorado.

Horizontal character of the strata of the Llano.—Section of the strata.—Absence of bluffs.—Character of the strata underlying the Llano.—Gypsum and red clays.—Probable Cretaceous age of the upper strata of the Llano.—Fossils.—Cretaceous at Doña Ana.—Possible presence of Tertiary strata.—Absence of Jurassic fossils.—Red sandstone and Gypsum formation of Delaware creek and the Pecos.—Gypsum of the Andes and Iowa.—Of Nova Scotia and Virginia.—Of Tuscany, Italy.—Extent of the American formation.—Geology of the plains between the Rio Grande and the Guadalupe mountains.—Sand-hills.—Saline lakes.—Springs.—Artesian wells.

The regular horizontal character of the Llano, and the form of its river valleys, are sufficient, without further evidence, to satisfy the geologist that it consists of horizontal strata of rock; a conclusion which is supported by the observations of all who have visited the region. The sketches of the borders of the Llano, accompanying the report of Captain Marcy, all show, with beautiful distinctness, the stratification of the rock in horizontal planes. So also the sketches brought in by Lieutenant Whipple exhibit successive layers of rock cropping out on the sides of gorges and cañons, and again resting upon the tops of mounds, in broad, table-like summits. Dr. G. G. Shumard, the geologist who accompanied Captain Marcy in his expedition to the sources of the Red river, has described the horizontal strata of the Llano, and we are indebted to him for the first geological section of the formation. This section was taken at the borders of the plateau, near the south fork of the Red river, in latitude 34° 30′, where the bluffs have a height of 600 feet above the prairie below. The base of the bluffs was formed of a deposite of red clay 400 feet thick, with a layer of saccharoid gypsum twenty feet thick above it; this was surmounted by strata of grey and yellow sandstone, alternating with thin seams of non-fossiliferous limestone; and the upper stratum, about 100 feet thick beneath the soil, is of drift with small boulders.[1]

As on the line of survey there were no abrupt or precipitous borders to the Llano, the opportunities for observing the character of the strata were not as favorable as are presented further north. Mr. Byrne, in his Diary, under date of March 6th, mentions the occurrence of gypsum along the borders of Delaware creek, and the next day he describes several caves in gypsum. Lieutenant Marshall, who examined the Pecos river as high up as the Sacramento, reports that the country over which he passed was a rolling prairie, and the soil was a mixture of clay and decomposed gypsum, evidently resting on a bed of limestone, and on a conglomerate of limestone and clay, which outcrops at several points along the river. "On the left or east bank of the river is the broad plain of the Llano Estacado, which evidently has for its basis the same conglomerate rock mentioned above."[2] He also found red clay and gypsum on the banks of the Sacramento river. Captain Pope also mentions immense outcrops of gypsum and selenite in "bluff banks fifty feet high along the Pecos;" and states further, that "numerous caves of pure gypsum of dazzling whiteness within, are found in this gypsum formation, which extends over a distance of 150 miles along the route."[3] From these facts, and the configuration of the Llano, I am led to regard its substrata as similar to those further north, where it has been more

[1] Report of an Exploration of Red river in 1852, by Captain Marcy. [Appendix D, Geology, p. 168, pl. 10.]

[2] Report of Captain Pope, p. 65. [3] Ibid, p. 28.

thoroughly examined. According to Lieutenant Whipple and Mr. Jules Marcou, the geologist who accompanied him, the base of the Llano along the Canadian is composed of the red and blue clays or marls containing gypsum; above them are white and yellowish sandstones and limestones, also in horizontal strata.

The geological age of these strata of red clays, sandstones, and gypsum, has not yet been satisfactorily determined; the formation appears to be singularly devoid of fossils, and, as yet, the only indications of its place in the geological series are its mineral characters and relative positions. The age of the overlying rocks of a lighter color is also obscure, but there is much reason to regard them as Cretaceous and Tertiary. The only fossils which I find in the collection from the Llano are Cretaceous, and serve to indicate the development of that formation at the Big springs of the Colorado, and a point on the Llano twenty miles east of the Sand hills. There are no fossils from the gypsum formation, nor any specimens which serve as a guide to its age. The fossils referred to are well preserved specimens of *Gryphœa Pitcheri* and *Exogyra Texana;* several specimens of limestone from the bluff at the Big springs of the Colorado, which contain a small *Gryphœa* like *G. vomer;* and a mass of shells much broken, but containing fragments of *Gryphœa* from a point twenty miles east of the Sand hills. Descriptions of these fossils will be found accompanying this report. They are all characteristic of the Cretaceous formation; *Gryphœa Pitcheri* being a well-known fossil of wide distribution in the Cretaceous formations of the United States. The altitude of this locality of Cretaceous fossils at the Big springs, according to the profile from the Pecos to the Big springs, is 3,844 feet above the sea.

The existence of the Cretaceous formation in the valley of the Rio Grande, between El Paso and Doña Ana, has been determined by Major Emory, by observations in connexion with the United States boundary survey. That part of the valley has an elevation of near 4,000 feet above the sea, and the west edge of the *mesa* opposite Doña Ana is 4,460 feet, which, according to the profile, is about the mean elevation of the Llano Estacado. The identification of horizontal Cretaceous formations at this point, at the same elevation with the formations of the Llano, also horizontal, is good evidence of their similarity in age. We have, therefore, three points at nearly the same elevation, yet separated by many miles, which are shown to be Cretaceous by the fossil remains. Two of these localities are upon the Llano, and the other is on the Rio Grande river, and the elevation of each is that of the general surface of the Llano in that latitude. It would appear, therefore, that its upper strata are of the age of the Cretaceous. Further observations and collections of fossils from the plain are, however, very desirable to verify these indications and probabilities.

The specimens of the rocks from the Llano Estacado have a general resemblance to each other, and show the nearly uniform nature of the geological formation. They consist, for the most part, of light-colored, whitish, or grey calcareous sandstones, with specimens of compact amorphous limestone, which resembles the specimens containing the Cretaceous fossils from the Big springs. Three or four specimens consist of sand and gravel united by a calcareous cement, and looking as if these materials had been exposed to the infiltration of water highly charged with carbonate of lime. (See descriptions and catalogue Nos. 23 and 24.) These have a very modern aspect, and much resemble the sandstones and conglomerates of the Tertiary age. Indeed, all the specimens of the sandstones of the Llano are so much like those of the Tertiary, that if it were not for the presence of the Cretaceous fossils, I would have been led to regard them as of that period.

Mr. Jules Marcou, who passed over the Llano with Lieutenant Whipple, near the parallel of 35°, regards the base of the Llano, or the formation of red clays, sandstone, and gypsum, as of the age of the Trias, and the upper strata—the light-colored sandstones and limestones—as Jurassic. In the preliminary observations he made upon this route, based upon Captain Pope's notes and collections, and published in the preliminary 8vo. edition of his report, he assigns the same ages to the corresponding parts of the Llano on the line; and says that the rocks covering the variegated marls of the Trias, and forming the whole plain of the Llano

Estacado as far as the Pecos river, belong to the Jurassic epoch. I do not find in the collection any specimens or fossils which present evidence of the existence of these formations, and I do not know the foundation for Mr. Marcou's assertion.

The collection which Captain Pope made along the banks of Delaware creek is entirely different in character from that made on the Llano. The color of the sandstones is not light buff and grey, but is red; and the frequent occurrence of the specimens of opaque and transparent gypsum shows clearly that the creek has worn its way downwards in the great gypsum formation. This is also true of the Pecos, for it is indicated by the specimens; and Captain Pope has described a great bed of gypsum, which appears along its banks, and is fifty feet thick.[1] This is said to be translucent, and sufficiently so to be used by the people of New Mexico instead of glass. Captain Pope also states, in addition, that "numerous caves of pure gypsum, of dazzling whiteness within, are found in this entire gypsum formation." This indicates that a large part, if not the greater portion of this great bed, is the opaque amorphous variety. This is truly an enormous bed, and exceedingly interesting in many points of view. Much thicker deposites are, however, found in South America, along the western slope of the Andes, where, according to Mr. Darwin, beds of gypsum alternate with red sandstone and shales, and, in some instances, are not less than six thousand feet thick.[2] Thick beds are also found in the Carboniferous formation of Iowa, where, according to Dr. Owen, the beds are from twenty to thirty feet thick.[3] The enormous deposites of gypsum in Nova Scotia are well known as the sources of the vast quantities used in agriculture and the arts in the United States. These deposites occur among the shales and sandstones of the Carboniferous period, and are well described in a recent volume by Mr. Dawson.[4] The gypsum is found there in many varieties, in thin seams of selenite, in reddish and fibrous veins, and in opaque and amorphous masses; often containing anhydrite in seams and crystalline nodules. In the district of Colchester, on the Shubenacadie, there is an immense mass of gypsum, named White's or the Big Plaster rock, which once presented a "snowy front of gypsum, nearly 100 feet in height;" but which has been greatly reduced by the operations of the quarry-men, who bring down enormous quantities by blasting.[5] The great deposite at Plaister Cove, Cape Breton, contains a bed which Mr. Dawson estimates at fifty yards in thickness.[6]

Extensive deposites of gypsum are also found in the Preston Salt valley of Virginia, where, according to Prof. H. D. Rogers,[7] it occupies an extensive fault or break in the Umbral or Carboniferous strata of that region.

According to W. J. Hamilton, esq.,[8] the great gypsum beds of Italy, which furnish the masses of beautiful alabaster used for various ornamental purposes, are found in the Tertiary strata of Tuscany, associated with a blue marl. Fossils of the genera *Dentalium*, *Cardium*, *Venus*, *Cerithium*, *Pleurotoma*, *Turritella*, and a large *Ostrea*, occur in the formation. The gypsum occurs in detached, irregular masses of great size, and also in continuous beds. Regular strata are found near Castellina, where it is mined extensively. The beds have a slight inclination, and consist of regularly-alternating strata of blue clay and grey gypsum; the latter containing nodules or spheroidal blocks of the pure white alabaster. He states: "In the

[1] Report of Captain Pope, p. 28.

[2] Darwin's Voyage of the Beagle.

[3] With respect to these beds, Dr. Owen makes the following statement: "For thickness and extent, this is by far the most important bed of plaster-stone known west of the Apalachian chain, if not in the United States. It is seen at intervals for three miles, exposed, on both sides of the Des Moines, in mural faces of from eighteen to twenty-five feet, always overlying pink shales, from beneath which copious springs of excellent water issue. It has been traced in the ravines, back from the river, for nearly three-quarters of a mile, where it is finally lost under the deep alluvion of the vast plains that stretch away to the west. There is every reason to believe that it occupies an area of from two to three miles square, retaining an average thickness of twenty feet; perhaps double that thickness at certain points." [Report of a Geological Survey of Iowa, Wisconsin, and Minnesota. By Dr. D. D. Owen: Phil., 1852, p. 126.]

[4] Acadian Geology. By J. W. Dawson: Edinburgh, 1855.

[5] Ibid, p. 232.

[6] Ibid, p. 279.

[7] Report on the Salt and Gypsum of the Preston Salt Valley of Virginia. By Prof. H. D. Rogers: Boston, 1854.

[8] Quarterly Journal of the Geol. Soc. Lond., vol. i, p. 273.

shaft of the mine, I observed five distinct beds of gypsum alternating with the blue clay, and varying in thickness from five to twenty feet."[1]

The formation which was partly traversed by the survey, although, perhaps, equalled in the thickness of the beds by other localities, is nevertheless the most remarkable for its extent, and for the number and variety of the gypseous beds of all degrees of transparency and of many colors. Captain Pope observes that it extends over a distance of one hundred and fifty miles along the route. It was found along Delaware creek, the Pecos, and again at the sources of the Colorado, at the eastern margin of the Llano. The same formation is largely developed along Red river and the Canadian; and the explorations of Captain Marcy and of Lieutenant Whipple have added greatly to our knowledge of its character and extent in that direction. Captain Marcy, in a letter to Professor Hitchcock in 1852,[2] observes that he has "traced this gypsum belt from the Canadian river, in a southwest direction, to near the Rio Grande in New Mexico. It is about fifty miles wide upon the Canadian, and is embraced within the 99th and 100th degrees of west longitude. Upon the North, Middle, and South forks of Red river it is found, and upon the latter is about one hundred miles wide, and embraced within the 101st and 103d degrees of longitude."

With regard to the geological age of this interesting formation, we are yet without full and satisfactory evidence. Observations on this subject, and additional remarks upon the gypsum, its uses, value, &c., will be found in a subsequent portion of this report.

Plains between the Rio Grande and the Guadalupe mountains.—It is difficult to form a satisfactory conclusion regarding the geological character of the plains between the Guadalupe, the Hueco, and the Organ mountains. The collection is without specimens from the strata underlying this part of the route. It is only possible, therefore, to infer the geology from the topography and the general character of the regions as compared with the adjoining plains, the geological character of which is already indicated by fossils. These determined points are the Llano Estacado on one side, and more particularly the well-known Cretaceous plains of the Rio Grande, at Doña Ana, on the other. This locality of the Cretaceous was well determined by the collections of the United States boundary survey, many Cretaceous fossils having been obtained. The elevation of the locality is nearly that of the plains under consideration; and I am led to infer that they are formed of Cretaceous strata, and have so colored them on the map. Further explorations of the region will, perhaps, lead to the discovery of Tertiary strata overlying the Cretaceous, and the exact limits of the formations will only then become known.

Sand hills.—Hills of dry, blown sand, appear to be a prominent characteristic of the surface of the Llano, and must greatly add to its desert-like and barren appearance. From the Diary of Mr. Byrne, it appears that they were encountered before reaching the Llano, and on the west side of the Hueco mountains. Between camps 11 and 12, on the plateau between the Hueco and Guadulupe mountains, a long belt of sand hills was also found, and the wagons travelled for seven miles at their base. Smaller hills were also seen for a long distance from camp, all composed of fine white sand. But these accumulations of sand do not compare in magnitude or extent with those encountered on the broad Llano, where, according to the same observer, the hills extend for fifty miles from north to south, with a breadth of fifteen miles from east to west. This is the great accumulation of sand on the Llano, and forms a conspicuous feature on the map; it is certainly the most extensive accumulation yet known in the interior; the belts of sand hills on the Colorado desert of California being much inferior in magnitude. In the remarks of Captain Pope upon the Llano Estacado, he states that the Llano is bordered on the south by a range of sand hills of white drift-sand, absolutely destitute of vegetation, and rising seventy feet above the general level of the plain. He further observes: "These hills, over a distance of thirteen miles, present steep ascents through short distances in many places; and the loose, moveable character of the sand, and its depth, render the passage through it with

[1] Quart. Jour. Geol. Soc. London, vol. i, p. 282.

[2] See Report of Captain Marcy—Appendix D.—Geology by Prof. Hitchcock, p. 172.

wagons next to impossible. On approaching from the east or west, these hills bear every appearance of the sand ridges along the coast of South Carolina and Florida, and the first hard wind will destroy the traces of the most numerous party."[1] Mr. Byrne states an interesting fact, that water is found in abundance among these hills, resting in basins of the purest sand. It appears that water could be at any time procured by going about half a mile from the road among the hills. This fact is somewhat difficult to explain, but it is probable that the water occupies a depression in the subjacent rock, and that it serves to retain the sand as it blows over the plain; and the sand, in turn, protects the water from the complete evaporation which would probably result if the surface was fully exposed to the air. The fact that the sand hills have accumulated in that place, shows the existence of some natural obstacle, or a peculiar configuration of the surface; for when driven before the wind, sand does not come to rest, except under the lee of some obstacle. In all cases where sand progresses before the wind in drifts, one of the slopes—that towards the wind—is more gentle than the other; that slope turned from the wind, or on the lee side of the drift, being the most abrupt. This sand is doubtless derived from a superficial covering of drift upon the Llano, or from the sandstone strata. Mention is frequently made of a hard gravelly surface before the belt of sand hills was reached, and I do not doubt that this sand is swept out from the gravel and small boulders by the wind, and perhaps derived in part from the disintegration of the soft sandstones of the upper part of the mesa. This view is supported by the examination of the specimen of the sand which Captain Pope brought, in No. 77. It is very clean and white, and consists chiefly of silicious grains, much rounded by attrition. They are colorless, and some are transparent. When treated with chlorohydric acid, effervescence takes place, and continues for some moments, showing the presence of a considerable amount of carbonate of lime. This indicates that the sand is derived from the decomposition of the white calcareous sandstone of the region. The sand of the hills on the Colorado desert also contains a very considerable amount of carbonate of lime. It is probably derived from the calcareous cement which invests the pebbles, forming a conglomerate on the surface of the plain, above the alluvial formations of the Desert. This conglomerate is Tertiary, or Quarternary; and the sand is swept from it by the wind, leaving a clean surface of pebbles, like a pavement.

Saline lakes.—A very peculiar and interesting feature of the surface of the Llano and the table-lands west of the Guadalupe range, is the presence, in the lowest parts of these plains, of shallow ponds or lakes, which are generally sulphurous or saline. Of this character are the Mustang springs, consisting of several lakes or pools with highly saline water. The *Ojo del Cuerbo,* or Crow spring, at the western base of the Guadalupe Pass, is in connexion with two small lakes covering four or five acres of ground, which are sulphurous; and about one and a half mile west of them two salt lakes are found.[2] Mr. Byrne also describes a dry salt lake, two and three-quarters miles across, near camp 22 on the Pecos river. It was covered with a salty efflorescence, and, on digging through it and the soil to a depth of two and a half feet, water was obtained highly charged with salts.

It thus appears that lakes or ponds of this character are quite numerous on the Llano, or in the vicinity of the route. Captain Pope's general observation doubtless gives the true explanation of the origin of most of them. He states that they were dry in the month of March, but that they probably contain water during the rainy season. The salt is derived from the substrata or porous rocks of the plain, being dissolved out by the rain water in its percolation through them, or passage over the surface; thus, each successive evaporation of the water in the low grounds adds to the accumulation of salt.

I find in the collection a specimen (No. 72) taken from the bed of one of the salt lakes, 15 miles west of the Guadalupe mountains. It is a light, porous earth, nearly white, and resembling some forms of travertin. It crumbles readily in the fingers, and dissolves partially in chlorohydric acid with violent effervescence. The solution thus obtained contains a large quantity of car-

[1] Report of Captain Pope, p. 9.

[2] Report of Captain Pope—Diary of J. H. Byrne, p. 55.

bonate of lime, a little magnesia and alumina, with traces of oxide of iron. A large insoluble residue remains. The specimen is apparently a remnant of a rock—probably a silicious limestone—altered by the action of sulphuric acid.

Small salt ponds and dry lake-beds incrusted with white salt, are very common on the plains and valleys of California, especially in the vicinity of Tertiary strata. It is possible that some of the deposits Captain Pope observed have a similar origin; but there is no evidence in the collection of the existence of Tertiary formations. The drift deposit, which has been described by Doctor Shumard as covering the rocks of the Llano, may, and very probably does, belong to the age of the Tertiary; but the materials and facts that were procured by Captain Pope are not sufficient to warrant any conclusions on this point.

Springs.—Other sources of these accumulations of saline water, and which appear to be very common in the region examined, are the springs at different points of the route, which, for volume and persistence of flow, are truly remarkable for that region, which is so arid and desert-like. Several of these springs are in direct connexion with salt lakes or ponds. The Ojo del Cuerbo has already been mentioned, and another example is found in the Big springs of the Colorado, which, according to Captain Taplin, "issue from a ravine on the northeast slope of a range of hills 200 or 250 feet high, whose general direction is S. 45° E. At a distance of one and a half mile, the outlet of the springs joins the valley of the salt lakes, and becomes at this point dry. Many of these lakes contain water; the beds when we passed being moist, and the water totally unfit for use."[1]

He again observes, in relation to a valley about eight miles from the Mustang springs, that it contains at its northwest extremity a chain of salt lakes, "which have a course a little south of east, their outlet passing only a mile and a half east of the Big springs of the Colorado, which are tributary to it." At the northern extremity of the same valley, the outlet to the Sulphur springs of the Colorado joins this chain of lakes. This Sulphur spring is described as "at least fifteen or twenty feet deep, and about twenty yards wide."

Captain Pope's observations on the springs and lakes or ponds of Delaware creek, are interesting in this connexion. He describes the creek as a "succession of small lakes, ten or fifteen feet deep, connected by a swift running stream." "It has its source in a limestone bluff, about fifty feet above its valley, and issues from the base of the bluff from seven or eight springs both pure and mineral. The largest of the pure springs bursts boldly out of the north side of the hill in a stream as large as a barrel, and, after a course of probably fifty yards, it unites with the small streams from the mineral springs. These springs contain sulphur in various proportions—in some barely perceptible, while in others it gives out an odor which is sufficiently perceptible at fifty yards. There are six of these sulphur springs. From the south side of the bluff issues a spring strongly impregnated with soda, and all the springs uniting in one of the small lakes or ponds of Delaware creek form a compound detestable both in smell and taste. The animals, to my surprise, greatly preferred this lake to the pure water of the spring."[2]

Prof. James C. Booth has made some interesting observations upon the specimens of the water from these springs, which were submitted to him by Captain Pope, and the results are found in the table appended to his report.[3] It appears that they contain very considerable quantities of sulphide of sodium and common salt. The earth which Captain Pope collected, and which had a sulphurous odor, I have had examined, and it was found to contain over 18 per cent. of sulphur.[4] Alumina, oxide of iron, lime, magnesia, and sulphuric acid were found in the aqueous extract.

Captain Pope also describes the Independence springs, sixteen miles from the head of Delaware creek, as bursting out from the surface of the ground in a small valley or depression of the table-lands. There are two springs, and by their union they form a small stream, which becomes dry a few miles below. "These springs are about five feet in diameter, and, although

[1] Report of Captain Pope, p. 78.
[2] Report of Captain Pope, Appendix C, p. 95.
[3] Report of Captain Pope, p. 30.
[4] See description, under the head of "Sulphur."

a pole ten feet long was thrust into them, the bottom was not reached." Five miles further west another spring was found, and still another large one four miles beyond, which gave rise to a stream.

Lieutenant Garrard reports numerous localities of good water at the eastern base of the Guadalupe range, south of Captain Pope's main line of survey. He found it in natural tanks, about thirty-five miles southwest from the head-springs of Delaware creek, and in several water-holes. These were all filled with rain-water, and, from its quantity and other appearances, it was considered probable that a supply would be found at all seasons of the year.[1]

Artesian wells.—The frequent occurrence of springs with such a volume of water as Captain Pope describes, shows the existence of vast quantities of subterranean water, which probably flows below or between the nearly horizontal strata of the Llano. In fact, it would appear that the Colorado and Brazos rivers, or their affluents, which take their rise at or in the borders of the Llano, are supplied by springs gushing out in the ravines. These facts are of great value and importance, and leave scarcely a doubt that water can be obtained on the Llano by boring. The nearly horizontal or slightly undulating position of the strata, and the variation in their mineral character which is known to exist, especially the alternation of compact beds of limestone, sandstone, and clays, present all the requisite conditions for retaining the water under pressure. All descriptions of the strata of the Llano agree in placing at their base a thick formation of red clay, and above it more sandy and porous rocks. We have, therefore, in the clay an impervious substratum, serving to retain the subterranean water in the more porous beds above. These pervious beds are believed to alternate with impervious ones, and thus the underground flow of water is confined. In order, however, that water should rise to the surface, or overflow from artesian borings, the strata which confine it must be inclined, or formed into basin-shaped depressions, so that one portion of the water-bearing stratum is higher than the point pierced by boring. On the Llano the strata, although described as horizontal, doubtless present not only a considerable degree of inclination towards the east and southeast, as shown by the gradual inclination of the surface, already described; but flexures or extended bends and depressions in the strata doubtless exist. Such variations from a horizontal plane are found in every extended sedimentary deposite, even where the strata have not been disturbed by convulsive changes of the earth's crust. Indeed, a perfectly horizontal mass of strata over broad areas is unknown to geologists. The occurrence of the dry salt lakes and the ponds on the surface of the plain; the depressions which become filled with water during the rainy season only, all indicate the existence of corresponding depressions in the underlying strata. I do not find any evidence in Captain Pope's observations, or in those of his party, to justify me in the conclusion that the strata of the Llano are upheaved, dislocated, or distorted by the uprising of the Guadalupe mountains. This appears to be Captain Pope's impression, based, perhaps, upon the statement of Mr. Marcou, who did not visit the district Captain Pope explored. The configuration of the Llano, its topography and generally level character, are, to me, insurmountable objections to this view. The intrusion or the uplift and folding of such a mass of mountains as the Hueco range and the Guadalupe, in whatever manner it took place, would have produced most decided flexures and abrupt folds of the strata of the Llano, so as to completely destroy its character as a plain. The configuration of the region is opposed to the opinion that the mountain ranges are more recent than the strata of the Llano. A disturbance of this nature is not, however, necessary, as has already been shown, to the production of the uneven condition of the strata requisite for obtaining water by boring. The gentle inclination of the plain and the strata from the mountains eastward, amounting in the whole breadth of the Llano to at least 400 feet, according to Captain Pope's measurements, is sufficient to give water at the surface of the eastern margin from a depth equally great, provided the permeable strata were fully charged, and the water did not suffer retardation by friction. It is possible, however, and indeed most probable, that the difference of elevation is much greater than 400 feet; and, if so, water could

[1] Report of Captain Pope—letters of Lieutenant Garrard, p. 63.

be obtained at the surface from a correspondingly greater depth. We must not expect to gain water at the surface from a depth greater than the difference between the elevation of the western edge of the Llano and the point of boring. This observation is made on the assumption that it is to the western edge of the Llano alone to which we must look for the supply of water. It is possible that the strata are supplied with water from the northern or northwestern borders of the Llano, and in this case water may be obtained from depths much greater than those mentioned. The difference of elevation of the plain from north to south is not yet known, but, as we have already shown, it is probable that the surface gradually rises from the south towards the north and west, although the measurements along the 35th parallel, when compared with those of Captain Pope, do not exhibit a very striking difference of elevation.

It is very possible that water-bearing strata may be found nearer to the surface than the underlying clay formation—the red marls and clays of the gypseous series; and that basins and depressions of the strata, of a comparatively local character, will furnish water at the surface from a slight depth. To me, the existence of the springs at the borders of the Llano is the best evidence that is presented in favor of the presence of water in the strata. Its configuration alone does not appear remarkably favorable to the success of deep artesian wells.

CHAPTER IV.

Remarks on the Geology from the Llano Estacado to Preston.

General description of the country.—Red sandstone and gypsum.—Age of the Gypsum formation.—Absence of fossils.—Probable Carboniferous or Cretaceous age.—Gypsum of Nova Scotia in the Carboniferous.—Fort Belknap to Preston.—Section of strata.—Coal.—Carboniferous limestone.—Cross Timbers.—Cretaceous.—Loess.

This portion of the survey embraces a strip of country extending in a northeasterly and southwesterly direction, and over 300 miles in length. I cannot better introduce the few observations it is possible to make on the geology, than by quoting the general description of the section given in Captain Pope's report:

"The space between the eastern base of the Staked Plain and the Red river, at the parallel of 34°, is occupied by that portion of northern Texas drained by the tributaries of the Colorado, the Brazos, the Trinity, and the Red rivers. With rapidly-increasing advantages as you proceed eastward from the Llano Estacado, this region is well timbered, well watered, and possessed of a soil of extreme fertility, capable of sustaining a dense population. The entire country is so gently undulating in its surface, and presents such an abundant and well-distributed supply of wood and water, that it can be traversed in any direction with trains of wagons, and is of so genial a climate that little choice of the seasons is considered desirable in undertaking an expedition through it. A great portion of the timber of the region intersected by the Colorado and its tributaries, along this route, is the mezquite, which, about thirty feet in height, and from six to ten inches in diameter, divides about equally with the prairie lands this entire district of country. The Brazos and its tributaries are better supplied with oak timber of a larger size, the country is more undulating, and the water more abundant. Immense coal-beds, of good quality, crop out along the valley of the river, and every advantage of soil and climate is offered to the emigrant. A military post (Fort Belknap) has been established upon this stream, near the 33d parallel. But by far the richest and most beautiful district of country I have ever seen, in Texas or elsewhere, is that watered by the Trinity and its tributaries. Occupying east and west a belt of one hundred miles in width, with about equal quantities of prairie and timber, intersected by numerous clear, fresh streams, and countless springs, with a gently undulating surface of prairie and oak openings, it presents the most charming views, as of a country in the highest state of cultivation; and you are startled at the summit of each swell of the prairie with a prospect of groves, parks, and forests, with intervening plains of luxuriant grass, over which the eye in vain wanders in search of the white village or the stately house, which seem alone wanting to the scene. The delusion was so perfect, and the recurrence of these charming views so constant, that every swell of the ground elicited from the party renewed expressions of surprise and admiration."[1]

A vivid contrast is here presented by this beautiful and fertile region with the arid plateau of the Llano; and the change is coincident with the marked variation in the configuration of the country. The difference in altitude is not alone the cause of the change; the character of the soil is doubtless very different from that of the Llano; and this, with the number of streams giving abundance of water, and the climatic conditions incident to a lower level and greater proximity to the Gulf, are sufficient to explain this extraordinary fertility.

[1] Report of Captain Pope, p. 9.

The observations on the nature of the strata of this portion of the survey are very few, and I cannot, therefore, present many remarks upon them. In the Diary of Mr. Byrne, under date of April 15th, bluffs of red sandstone at the crossing of the Colorado are mentioned. Again, on one of the tributaries of the Brazos the Gypsum formation is mentioned, and its resemblance to that of Delaware creek is noted. April 19th, Captain Pope passed over a bluff or bank showing limestone and red sandstone in horizontal strata, with decomposed gypsum strewed thickly about. The water, too, was strongly impregnated with gypsum, or probably with salts of magnesia. From these facts, and the peculiar topography and the vegetation, I conclude that, from the time of leaving the Llano, at the springs of the Colorado, east, to the vicinity of the Clear fork of the Brazos, the route was upon the red sandstone formation, containing the enormous deposits of gypsum, and underlying the lighter-colored sandstones and limestones of the Llano—the continuation, in fact, of the same deposits which were traversed along the Pecos and Delaware creek, already noted and described. The quantity of gypsum, however, which is met with in this part of the formation, does not at all compare with that found on the Pecos, but the characteristic peculiarities of the formation were preserved.

Age of the Gypsum formation.—As in the first part of this report no observations upon the geological age of the Gypsum formation were presented, I now propose to briefly consider this subject, before passing to a description of the rocks around Fort Belknap, and from thence to Preston.

Much light has already been thrown upon the geology of this region by the labors of Doctor G. G. Shumard, in connexion with the exploration made by Captain Marcy.[1] The Red-sandstone and Gypsum formation has also been described by President Hitchcock;[2] but he does not decide upon its age, both from the absence of fossils, and the want of sufficient observations upon its position relatively to other formations, the age of which is well determined. For the same reasons, I shall not attempt to establish its geological age. Its position relatively to the Carboniferous formation, which it overlies, indicates that it may belong to the upper portion of that series. It may also be of Permian or Triassic age, to which formations it bears great resemblance in its mineral characters. It may also be Cretaceous, and fossils of this period only, have been brought from that region. That it is of the age of the Trias is the opinion of Mr. Marcou, who traversed the formation along the Canadian river with Lieutenant Whipple; and in the preliminary report on Captain Pope's collection, which he prepared, he distinctly states it to be Triassic, and overlaid by Jurassic strata. We have already seen that the evidence of the geological age of the upper strata of the Llano favors the conclusion that they are Cretaceous; and there is no evidence or indication of their Jurassic age, nor is there in the collection any fossil from the underlying red clays and sandstones by which their age can be established. Dr. Shumard, in his geological section from Arkansas to Fort Belknap, has represented the Cretaceous strata at Fort Washita as resting directly upon the coal-measures; and Professor Tuomey, the geologist of the State of Alabama, finds them in the same position, and without any intervening Triassic or Jurassic strata. The section which Dr. Shumard presents does not show whether the Cretaceous strata correspond in dip, or are conformable with the coal-measures below; nor is it easy to decide, from the descriptions, whether the coal-measures are horizontal or have a slight dip. An outcrop of bluish-grey limestone, about one hundred miles southwest of Fort Smith, is said to dip at an angle of 30°. A ridge of granite succeeds, and then sandstone is found nearly to Fort Washita, where it is covered over by the Cretaceous strata. The Carboniferous sandstones at Fort Belknap are described as nearly horizontal. It would thus appear that the Cretaceous formation of that region is found to lie conformably upon nearly horizontal Carboniferous strata. If this is true, may we not consider the red clays and sandstones of the Gypsum formation, upon which the Cretaceous of the Llano rests, as portions of the Carboniferous series? It is true, we are entirely without adequate data upon

[1] See Report of Captain R. B. Marcy, of an Exploration of the Red River in 1852—Appendix D, Geology, p. 179.

[2] Ibid, p. 164.

which to base an opinion or conclusion respecting the part of the Carboniferous series to which these strata may be referred; but, whether upper or lower, the group, if Carboniferous, differs materially from the Carboniferous formation as developed further to the north and east. The same difficulty arises if we consider the Gypsum formation as Triassic; the same apparent deficiency of strata, well characterized at other localities, exists.

There are many reasons for referring the formation to the age of the Cretaceous, for this is the only period represented by fossils; and from the wide extent of the strata, we are compelled to believe that they attain a very considerable thickness—a thickness greater than that of the light colored strata of the Llano above the red clay and gypsum. The whole series, from the surface of the Llano, of Cretaceous age, down to the underlying Carboniferous sandstones, might be regarded as Cretaceous. If we admit the mineral characters of the strata as evidence of the age of the formation, they will favor the conclusion that it is Carboniferous.

Dr. D. D. Owen (as has already been noted, page 18,) reports the existence of great beds of gypsum in the Carboniferous shales of the coal-basin of Iowa; the beds being from twenty to thirty feet thick. So, also, the great beds of Nova Scotia, which supply such large quantities of massive gypsum and alabaster for exportation, are in the Carboniferous formation, and not in the new red sandstone, or "Trias." Mr. Dawson, in his recent able and interesting work, entitled "Acadian Geology," gives detailed descriptions of these beds, and of their association with the marls, sandstones, and limestones of the coal period. The well-known gypsum-beds of Windsor, Nova Scotia, are found in connexion with a limestone containing fossils of the lower Carboniferous formation, of the genera *Productus*, *Spirifer*, and *Terebratula*. Mr. Dawson makes the following observations in regard to the position of the gypsum: "Above this limestone, in the order of succession, we have alternations of marls and limestones, and next a bed of white crystalline gypsum, contrasting strongly in its purity and whiteness with the other beds of mere mechanical origin. Here the shore becomes low, and no rock is seen; but a little to the eastward we find the great gypsum quarries of Windsor, excavated in the outcrop of a very thick bed, the strike of which would bring it to the shore just where our section fails, and where the gypsum has been removed, partly by the river, and partly by the quarrymen who earliest dug this rock for exportation. A little further to the southward, at the next bluff point, there is a very thick bed of limestone, filled with, or rather made up of, fossil shells of various species and genera, affording a remarkably perfect display of the shelly coverings of creatures that inhabited the Carboniferous seas."[1] The following species are enumerated, and figures given: *Productus Lyelli*, *Fenestella membranacea*, *Terebratula elongata*, *Ceriopora spongites*, and new species of *Orthoceras*, *Spirifer*, and *Conularia*. The bivalve shells are very numerous, especially four or five species of *Terebratula*, three of *Spirifer*, and three of *Productus*. The Carboniferous age of this Gypsum deposit is thus established; and I have been particular to present the evidence upon which the conclusion is based, as Mr. Jules Marcou, who regards the red marls and gypsum of New Mexico as Triassic, has affirmed their synchronism, or connexion with the Nova Scotia deposits of Windsor and Plaister Cove.[2]

I do not regard the physical and mineral characters of a formation as sufficient to establish its geological age, or relative position in the scale of palæozoic formations. In the absence of fossils, I do not, therefore, assign the age of the Gypsum formation; but its relative position, and its mineral characters, unite in showing it to be Carboniferous, or Cretaceous, rather than Triassic.

Fort Belknap to Preston.—According to Dr. Shumard,[3] the geological formations in the vicinity of Fort Belknap consist of nearly horizontal strata of fine-grained sandstone, shale, and soft, drab-colored, non-fossiliferous limestone, whose relative positions correspond with

[1] Acadian Geology. By John William Dawson: Edinburgh, 1855, p. 218.

[2] Report of Explorations for a Railway Route, &c., by Lieutenant A. W. Whipple. House Doc. 129: Washington, 1854, p. 42.

[3] Report of Captain Marcy of Exploration of the Red River in 1852.—Appendix D, p 182.

strata of the same character, largely developed between Fort Washita and Fort Smith. He also gives the following section, taken at a point about one mile from the fort:

1. Arenaceous subsoil of a red color; thickness ..... 3 to 10 feet.
2. Black shale, soft, and rapidly disintegrating ..... 4 "
3. Seams of bituminous coal, from ..... 2 to 4 "
4. Fine-grained sandstone of a yellowish-grey color, and containing fossil ferns; thickness variable.
5. Grey non-fossiliferous limestone; thickness unknown.

A number of seams of bituminous coal, varying in thickness from two to four feet, have been opened along the river, and the coal made use of at the fort. Dr. Shumard also states that the characteristic fossil ferns of the Carboniferous era have been found with this coal, and considers the age of the formation established.

I learn from Colonel Loomis, the commanding officer at Fort Belknap, that there is an abundance of hard blue or grey limestone about three miles below the fort, and that a quarry has been opened there, and several thousand bushels of good lime burned from the rock. It would appear that the Carboniferous limestone occurs at this point; and I am confirmed in this opinion by a *Productus* which was taken from the quarry.[1] The Carboniferous age of the coal is thus rendered more certain. Further observations on the coal will be found in Chapter V of this Report.

Between Fort Belknap and Preston, the remarkable belts of wooded country, known as the Upper and Lower Cross Timbers, indicate a change of soil, if, indeed, they do not mark out the borders of a geological formation. Dr. Shumard found that the Cretaceous formation developed at Fort Washita was continuous to the southwestern margin of the Cross Timbers.[2] I find in the collection several fragments of *Gryphæa*, a Cretaceous fossil, from the Elm fork of the Trinity; and a mass of broken shells, probably of *Exogyra Texana*, also of Cretaceous age, from the banks of Red river, near Preston. From these facts, I have ventured to conclude that the route was upon the Cretaceous, from the western margin of the Cross Timbers to Preston, and have so indicated it upon the map and section.[3]

From the preceding observations, it appears that, after leaving the strata of the Llano Estacado, on the western border of the Colorado river, the route was upon the Red-clay and Gypsum formation until it reached the Clear fork of the Brazos, where it is probable the coal-measures commence, and continue to a point a few miles east of Fort Belknap, and are then succeeded by Cretaceous strata to the termination of the line of exploration at Preston, on the Red river. There is nothing in Captain Pope's report to indicate the exact boundary or limit of the coal-measures between Belknap and the Gypsum formation; and I have been guided by the topography alone in assigning this line to a point near the intersection of Captain Pope's trail with the Clear fork of the Brazos.

The great fertility of the soil found through this region is thus explained by the number of the geological formations, all traversed by numerous streams and their tributaries, which transport and mingle the detritus from all the strata, so that a soil of complex composition is produced. It is more than probable that formations more recent than the Cretaceous are developed along the line east of the Colorado. We should expect to find horizontal strata of the Tertiary period imposed upon the Cretaceous beds, but the collection does not indicate that the formation was passed over.

[1] I am indebted to Mrs. Loomis for this fossil, which removes all doubt of the Carboniferous age of these deposits.

[2] Marcy's Report, p. 181.

[3] I have marked the boundary of the Cretaceous as far west as the western margin of the Cross Timbers with some reluctance, as the general statement of Dr. Shumard does not permit the limit of the formation to be accurately plotted; and I have been led, from a consideration of the position of the outcrops of Carboniferous limestone, to consider that the Carboniferous strata were extended in a northeasterly direction from Fort Belknap for several miles beyond the first or most western belt of Cross Timbers—the Upper Cross Timbers. In the absence, however, of any more definite information, I have been guided by Dr. Shumard's statement.

Dr. Shumard found on the Red river, twenty-six miles from Fort Washita, a deposit of ash-colored loam, twenty-five feet thick, containing terrestrial and fluviatile shells of the genera *Lymnea Physa, Planorbis, Pupa,* and *Helix;* the whole resembling species found in the loam at New Harmony, Indiana, and elsewhere in the Mississippi valley.[1] This formation along the Mississippi constitutes what are known as the "Bluffs," and is a fluviatile accumulation laid down by the river when the region was at a lower level. In other words, it is an ancient alluvion. Its thickness and known extent along the Mississippi render it very probable that it will be found along most of the principal tributaries of that river. A similar deposit is found along the valley of the Rhine. Its thickness is from 200 to 300 feet, and it is a yellowish-grey loam, consisting chiefly of clay, combined with sand and carbonate of lime. The same deposit is found along most of the principal valleys or tributaries of the Rhine; it evidently having been contemporaneously deposited. It is known in Germany under the name of *loess.*

The occurrence of a formation along the Red river similar to those described, leads me to believe that it will be found along most of the rivers which are tributary to the Mississippi, and it is quite probable that, in the environs of Preston, and even over broad tracts of that region, there are extensive superficial alluvial deposits, which afford a soil that can scarcely be surpassed for its richness and fertility.

[1] Report of Captain Marcy—Appendix D, p. 183.

CHAPTER V.

Building-stones.—Coal.—Gypsum.—Lead.—Sulphur.

I.—BUILDING STONE.

Description of the principal specimens in the collection.—Remarks upon them and their distribution.

I PRESENT under this head a brief description of some of the most interesting rock-specimens in the collection, especially those indicating deposits which can be made use of for purposes of construction. These specimens are described according to their numbers in the catalogue, and the same descriptions will serve the purposes of the geologist.

No. 3. *Granite from Hueco mountains.*—This is a very fine-grained and compact grey, sienitic granite, the crystals of hornblende being very small, and appearing as small black grains. The feldspar is white and glassy. A fragment of white limestone accompanies these specimens.

No. 5. *Limestone from head spring of Delaware creek.*—This is a very compact, dark-colored rock, and breaks with a conchoidal fracture. The weathered surface is grey. When struck, or if cut with a knife, a peculiar bituminous and offensive odor is produced.

Nos. 6 *and* 8 are similar to No. 5.

No. 17. *Limestone from foot of Guadalupe mountains.*—This is a very compact, firm rock, of a greyish-white color, and sub-crystalline grain—saccharoidal. It contains some slight cavities, rendering it somewhat porous, but it may be regarded as a good and elegant building material.

No. 9. *Sandstone from Guadalupe mountains.*—This is one of the firmest and hardest sandstones in the collection. It has an even grain and pleasing drab color, but weathers with a dark, rusty brown surface. The mass, when held in certain positions, reflects the light as if from a cleavage surface of carbonate of lime. It effervesces violently with chlorohydric acid, and is, evidently, highly charged with carbonate of lime.

No. 36. *Sandstone from Llano Estacado.*—This specimen much resembles No. 9, but is more compact, and probably contains more lime. The brilliant reflections noticed in No. 9 are very evident here, and are manifestly due to a partial crystallization of the carbonate of lime. The color of this specimen is a rusty brown, and darker than No. 9.

No. 27. *Sandstone from east side of the Pecos.*—This is a firm, compact specimen, of a uniform grain, and sufficiently tough for building purposes. It does not, however, look very durable.

No. 30. *Sandstone from Llano Estacado.*—This specimen is coarse-grained and quite friable. It contains a notable quantity of carbonate of lime, and probably is not very durable if exposed to the weather. It resembles the Tertiary sandstones of the Bernardino Sierra, California.

Nos. 19, 20, 23, 24. *Sandstones.*—These specimens have a general resemblance. No. 23 has a reddish color, due to the presence of oxide of iron, but in other respects it much resembles No. 30, and, like it, may be crumbled away by the fingers on the thin edges. No. 19, from near the river, is peculiar. The little grains of sand are cemented by a thin white crust, which is carbonate of lime; and when the grains are crumbled out, small cavities are left in the calcareous mass. No. 20 is similar, but contains same large pebbles. No. 24 has the same general characters, but is much coarser. All these specimens have a modern look, and resemble the Tertiary sandstones along the margin of the Colorado desert, where some of the upper beds are highly charged with carbonate of lime in the form of travertin, or calcareous tufa.

No. 59. *Sandstone, from head waters of the Colorado.*—This is a very fine-grained red sandstone, resembling in texture and color the red sandstone of New Jersey and Connecticut. It is friable, and small fragments may be crumbled in the fingers.

No. 52. *Sandstone, from south side of the Brazos.*—This is a fine-grained stone of a light-grey color, and sufficiently compact and tough for ordinary building purposes. This specimen contains a large per centage of carbonate of lime.

No. 53. *Sandstones from head waters of the Colorado.*—These two specimens are alike in grain and hardness, but differ in color; one is red, and the other grey. They are not very tough, and both contain a large portion of carbonate of lime.

Nos. 56 *and* 57. *Ferruginous sandstone, from between the head waters of the Trinity and the Brazos.*—These specimens are interesting from the quantity of oxide of iron which they contain. The iron oxide appears to be the cementing material, and constitutes the principal portion and weight of the specimens. They are both very hard, and are not easily broken, but are not suitable for building purposes.

No. 69. *Ferruginous conglomerate, from near Fort Washita.*—This specimen is very rich in iron, and, indeed, may very properly be called an iron ore. Its association, however, with the silicious sand is not favorable for the manufacture of iron. It is not at all suitable for buildings.

No. 51. *Conglomerate, from affluent of the Trinity.*—This specimen is interesting, inasmuch as the material by which the pebbles are held together is *silex*. This silex invests each pebble, and fills up the spaces between them; it has a semi-opaline character, and in some places successive layers on the walls of the cavities are visible, showing a structure like agate. The silex has evidently been deposited by the infiltration of silicious water, which has thus produced a hard, firm rock. The specimen is a good illustration of the extent to which rocks may be changed and modified in their chemical and physical characters by the slow and quiet agency of infiltration of water holding foreign substances in solution.

It is thus evident that a considerable variety is found in the building materials along Captain Pope's route. The light-grey colored sandstones, however, appear to predominate, and are found at several points. The specimens of the best quality were from the following places: Guadalupe mountains, (where there is also limestone of good quality;) Llano Estacado, thirteen miles east of the Sand-hills, (No.36;) on the east side of the Pecos, (No. 27;) south side of the Brazos, (No. 52.) From the Hueco mountains the specimens of granite are very fine, and show that a very superior building-stone can be obtained there. It is by far the best building material in the collection, and probably can be obtained in any desired quantity. I believe, however, that many localities of sandstone will be found at convenient points along the route; and although many may not be of the hardest and toughest description, they are sufficiently firm and compact to endure for long periods in favorable situations. At Fort Belknap building-stone is not readily obtained in large quantities at any one point. When the quarters were in process of erection, considerable difficulty was experienced for want of good stone, and that which was used was taken from many different places, at a distance of one-half to one mile from the post.

The limestone which occurs a few miles down the river furnishes excellent caustic lime, and over 2,000 bushels have been burned there. I judge, from the descriptions, that good building-stone could be procured at the quarry.

The limestone specimens from the Llano do not give much promise; they are not sufficiently homogeneous and compact.

II. COAL.

Fort Belknap.—Carboniferous formation.—Lignite on the Brazos.—Probable extent of the coal.

The only locality of coal mentioned in Captain Pope's report is that at Fort Belknap, on the Brazos, and which has already been noticed in a general way (p. 27). There are no specimens of this coal in the collection, nor of any other from other localities. I learn, however, from Col. Loomis, the commanding officer at Fort Belknap, that this coal is of fair quality and burns freely, leaving a white or grey ash. It does not cause any trouble by slaging. This coal has been in use at that post for a long time, and excavations over twenty yards deep are already made into the bank, on the course of the vein or bed. The vein is horizontal, and about four and a half feet thick, and is divided in the middle by a thin layer of slate from one to four inches thick. It is found at many places along the river, and several places have been opened into, and good coal taken out. A layer of hard blue clay is found under the bed. An attempt to procure water by a well about sixty feet deep, which was made by General Belknap, at a point three-quarters of a mile from the river, resulted in the discovery of a bed of similar coal, which is probably the continuation of the same bed. When the coal was reached, the well was abandoned. The coal is taken from the mine in large blocks and masses, but when exposed to the air they fall to pieces.

Dr. G. G. Shumard is very positive in his opinion that this coal is of the true Carboniferous period, and says that it is characterized by the fossil ferns of that era. The description of the adjoining strata seems to indicate a more recent age for this deposit; in fact, according to the descriptions of the strata, they more nearly resemble Tertiary than Secondary deposits. Dr. Hitchcock has observed this, and in his report to Captain Marcy says: "Now, at first view, it would seem almost certain that we have here a description of a genuine coal formation of the Carboniferous period, not less than three hundred and fifty miles long, associated, moreover, with those valuable iron-ores which, in other parts of the world, are connected with such deposits; for, in descending through the formation, we find, first, overlying shale; then, coal; then, coal sandstone, or perhaps millstone grit; and then, perhaps, Carboniferous limestone. But it is well known that coal occurs in other rocks besides the Carboniferous, as in eastern Virginia in Oolitic sandstone, and in other places in Tertiary strata. These more recent coals are often of great value, as in Virginia, but they are not generally as good as those from the Carboniferous strata. It becomes an important question, therefore, to determine to what geological period the coal under consideration belongs. A few specimens of the fossil ferns would decide the matter, and I trust that Dr. Shumard is right in referring them to the Carboniferous era; but it is well known that analogous species occur in the higher rocks; and so coal, even in the Tertiary strata, is sometimes more or less bituminous. The evidence, however, appears to me to be strong in favor of this deposit being of the Carboniferous age. But in your letter of April 1st,[1] you state some facts respecting this coal that have thrown a little doubt over my mind. You say that 'the coal formation of the Brazos is found in a coarse, dark sandstone rock, which is a solid stratum, but is easily removed in consequence of being so soft. In excavating for a well, we passed through the sandstone and the coal. The greater part of the stone was removed with the mattock; and in the coal, which was here about sixty feet below the surface, we found fossil ferns, which, unfortunately, were not preserved.' The ease with which this sandstone was removed, requiring only a mattock, corresponds better with the hardness of Tertiary than of Carboniferous rocks; yet, in some parts of the world, distant from igneous rocks, the sedimentary strata are but little indurated."[2]

Beds of lignite or Tertiary coal are found at many places in Texas. A bed, four feet thick, is found on the Colorado river, near Bastrop, beneath a layer of Eocene fossils.[3] It also occurs on the Brazos, at the mouth of the Little Brazos. These localities are, however, nearly two

[1] Letter from Captain Marcy.

[2] Report of Captain Marcy, pp. 164, 165.

[3] Verbal communication from Dr. Moore, of Texas. June, 1855.

hundred miles distant from Fort Belknap, and probably have no connexion with the deposit at that place. It appears to me most probable that Dr. Shumard's opinion is entirely correct, and that the coal of Fort Belknap is of the Carboniferous era. The occurrence of the Carboniferous limestone in the vicinity, as shown by the *Productus* already mentioned, renders the Carboniferous age of the coal nearly certain.[1] It is most probable that this coal deposit is of great extent, underlying a broad area in Texas, and extending into New Mexico, under the great *Llano Estacado*, and possibly outcropping on the eastern flanks of the Hueco and Organ mountains.

III. GYPSUM.

General description of the mineral.—Its composition and uses.—Anhydrite.—Varieties of Gypsum in the collection.—Description of a specimen containing carbonate of lime.—Gypsum of Plaister Cove, Nova Scotia.—Applications of gypsum in the arts.—Quantity mined and sent to the United States.—Remarks on the origin and formation of the beds.

The geological peculiarities and relations of the Gypsum deposits which were passed during the survey, have already been described in the preceding portions of this report. The great extent of the deposit, however, and the wide distribution of the material, demand more than a consideration of its geological position and characters, as compared with other deposits. The peculiar and varied forms under which the gypsum appears, the phenomena of its formation, and its economical value, should be considered. As this Report will fall into the hands of many who are not familiar with the composition and properties of the mineral, I present a partial mineralogical description of the species and its varieties.

The mineral species *Gypsum* consists of sulphuric acid, lime, and water, combined, when pure, in the following proportions:

Sulphuric acid ($S\,O_3$)	46.51
Lime ($C_a\,O$)	32.56
Water ($H\,O$)	20.93
	100.00

Its formula is $C_a\,O, S\,O_3 + {}_2H\,O$. It crystallizes in beautiful transparent crystals, which belong to the monoclinic system, and are found with various modifications. These crystals may be split (cleaved) very readily in one direction, into beautiful and perfectly transparent thin plates, like mica, but not elastic, which are sometimes used instead of glass. These crystals are very soft, and may be scratched by the finger-nail, being a little softer than rock salt, or 1.5—2 on the scale of hardness adopted by Mohs. The specific gravity (of crystals) is about 2.3, being less than the gravity of carbonate of lime or limestone. It occurs of various colors, generally white, but sometimes grey, flesh-red, honey-yellow, ochre-yellow, and blue; while impure varieties are of various shades of black, brown, and red. It dissolves, without effervescence, in chlorohydric acid, and is soluble in 500 parts of pure water.

It appears in nature under many different aspects, as will be seen from the number of colors given above. It has also many varieties of form, being found in the small and perfect crystals; in broad thin plates, like glass; in fibrous masses, with a peculiar silky lustre; and in granular masses of different degrees of fineness of grain, both translucent and opaque. These varieties have received different names; the transparent plates are called *selenite*, from *selene*, the moon; the fibrous masses are called *satin-spar;* and the white and fine-grained amorphous varieties, suitable for carving, are known as *alabaster*. The ordinary compact opaque masses, which are

[1] Since the above was written, I have received a collection of fossils from the vicinity of Fort Belknap, made by Dr. Shumard, when with Captain Marcy, on his exploration of the country of the Witchita Indians. These fossils consist of two or three species of *Productus* and *Terebratula;* there are also many *Encrinites* and *Cyathophyllæ*, and a *Pleurotomaria*, from the coal-bed. They were collected at Belknap, and nine miles below, and at a point forty miles west. I have therefore marked the Carboniferous limestone on the map at these places.

used in agriculture and the arts, are very generally known under the name of gypsum, or *plaster;* which latter name, however, is more appropriate when applied to the powdered mineral.

When the masses of gypsum are heated, the water which is in combination is given off, and they are converted to a dry, white powder, like flour, which is called *plaster of Paris*, and has the important property of hardening when mixed up with a small quantity of water. The operation of expelling the water is called "boiling," although no water is used in the operation. The escape of the water in the form of steam keeps the mass in continual agitation.

Sulphate of lime also occurs in nature without any water, and forms another mineral species, called *anhydrite*. This has the following composition in 100 parts:

Lime (C_a O)	41.2
Sulphuric acid (S O_3)	58.8
	100.0

It is generally found associated with gypsum, and the two species are often found to pass into each other, forming a compound, with a smaller quantity of water than pertains to gypsum.

Captain Pope observed many of these varieties of gypsum on the line of survey, and it is possible that beds of anhydrite were also passed. The specimens which I find in the collection consist of the pure, transparent selenite (Nos. 7 and 25); a red, fibrous variety (No. 15); and a new and peculiar mass (No. 14), which is different from any hitherto described.

The descriptions already given of selenite will suffice for Nos. 7 and 25, but No. 14 deserves more than a place in the catalogue.

The specimen is about five inches long and two thick, and was taken from the banks of Delaware creek. It at first appears to be a stratified mass, being marked with regular lines like the divisions between strata. The main portion of the mass is white, opaque, and amorphous gypsum, but it is in combination with transparent selenite.

The white amorphous portions are in thin and parallel layers, about one-tenth of an inch thick, and they are separated by thin sheets of a different color, and about as thick as a stout card. The examination of these thin sheets shows them to consist of carbonate of lime. This result, which was unexpected, is very curious and interesting, and the formation of the mass cannot be readily explained. On the weathered surfaces of the specimen these layers of carbonate of lime are more distinct than on a freshly fractured surface, appearing at first as if they resisted decomposition better than the sulphate. A closer examination shows that the decomposition is most rapid at the line of junction between the carbonate and the gypsum, so that both layers stand out from the surface.

The transparent selenite, which traverses this mass, cuts obliquely across the opaque layers, both of the gypsum and the carbonate, cutting them off like a dyke traversing stratified rocks. Some of the layers of carbonate are, however, found in the mass of the selenite, preserving their parallelism and general characters, but not exactly parallel with the outer layers. The principal cleavage of the selenite is oblique to the layers, being inclined at an angle of about 45°.

An hypothesis which will explain all these phenomena is not easily formed. The whole appearance of the specimen, its stratified character, suggests its origin by successive deposition; but the extreme regularity in the thickness of the layers, and the absence of all granular structure, forbid this conclusion. It may, however, have been deposited from solution in successive layers, and the crystalline portion may have been subsequently formed from the material so laid down. It appears more probable that the whole mass is due to a segregating or crystalline force acting while the solution of lime was diffused in the strata of earth or sand, and bringing the particles together in one seam, as water, during its crystallization, is sometimes separated in layers from a bank of earth or clay.

Another specimen (No. 13) is very similar to No. 14, but the layers of sulphate of lime are thicker, and the specimen appears to have been broken from a different and a large mass.

The collection made along the 35th parallel, partly in the valley of the Canadian, contains several specimens from this same extensive Gypsum formation, which are peculiar for their deep-red color and the well-defined crystalline structure, showing that the color is not due to an ordinary mechanical mixture. The greater part of the mineral on the route, especially that on the Pecos, appears to be the white granular variety, the same in which the beautiful white caves are found. Captain Pope, however, mentions the selenite as if it existed in large quantities also. It would be very interesting to determine whether any portion of these beds are of anhydrite, or whether it is found isolated in the strata, apart from the gypsum. The occurrence of large quantities of anhydrite with the gypsum in the Carboniferous strata of Nova Scotia renders the inquiry still more interesting, as another mineral character might be added to the already numerous points of resemblance. I quote from Mr. Dawson's book a description of a part of the gypsum deposit of Plaister Cove: "About two-thirds of the thickness of the bed consists of crystalline anhydrite, and the remaining third of very fine-grained common gypsum. The anhydrite prevails in the lower part of the bed, and common gypsum in the upper; but the greater part of the bed consists of an intimate mixture of both substances, the common gypsum forming a base in which minute crystals of anhydrite are scattered, and bands in which anhydrite prevails, alternating with others in which gypsum predominates. It is traversed by veins of compact gypsum, but I saw no red or fibrous veins like those of the marl. In some parts of the bed, small rounded fragments of grey limestone are sparingly scattered along layers of the gypsum."[1]

The applications of gypsum in the arts, both in its raw state and prepared, or ground into plaster, are multiplied and various. It is an interesting fact, that selenite was well known to the ancients, who, according to Pliny, made bee-hives out of it, in order to see the bees at work within. According to Dr. Hitchcock, it was used by the wealthy and in palaces for windows, under the name of *Phengites*, and "has the curious property of enabling a person within the house to see all that passes abroad, while those abroad cannot see what passes within. Hence Nero employed it in his palace."[2] The uses of alabaster are well known. Large quantities are worked into ornamental objects—vases, statuettes, &c.—in the establishments of Florence and other places in Europe.[3] The fibrous variety, or satin-spar, is sometimes used for making ornaments and beads, called *Roman pearls*. But by far the most important applications of gypsum in the arts, are those of plaster of Paris. In this state it is used for moulds, casts, statues, as a cement, for plastering walls, and for ornaments on ceilings. The crude, unburnt gypsum, when powdered, is largely used in agriculture as a fertilizer. Enormous quantities of this substance are thus annually consumed in the United States. It is brought from the quarries of Nova Scotia, and finds its way, by rivers, canals, and railroads, to nearly all parts of

[1] Acadian Geology, p. 280.

[2] Marcy's Report, p. 173.

[3] The following description, by W. J. Hamilton, esq., of the gypsum and alabaster mine near Castellina, in Tuscany, is interesting in this connexion:

"We entered the mine by an inclined path, and, passing under ground, soon reached an open well, or large inverted cone, around which the inclined path is carried, and where the section of marls and gypsum is well exposed. As the descending road passes through the third and fourth gypsum beds, galleries are seen striking into the rock in all directions. The first and second gypsum beds are of a uniform character and grey color, and do not contain any alabaster blocks. These are found, principally, in the third and fourth beds, and occur as irregular, isolated, spherical masses, imbedded in the gypsum, from which they are, mineralogically speaking, distinctly separated by a thin black crust, which indicates to the workman the existence of the finer nodules. These nodules are most frequent in the lower part of the stratum, and occur in regular layers, never touching, although varying much in their distances from each other. In bed number 3 there are two layers of these nodules, and in number 4 there are three. They vary much in size, weighing from 20 or 30 pounds to upwards of 2,000 pounds. When the workman discovers the black crust, he is at once aware that he is near a block of alabaster, and, by following the direction of the crust, he removes the gypsum all round until he has nearly detached the whole nodule, which is at last carefully separated from the parent rock. Gunpowder is occasionally used to blast the rock, when no black crust indicates the existence of the alabaster. This crust, in connexion with the pure alabaster, is, perhaps,

the country. It is even taken in quantities from the sea-board, by railway, far into the interior, to the broad fields of northern Virginia, situated on the new red sandstone or "Trias." Some idea of the extent to which this substance is used in agriculture may be obtained from a knowledge of the amount taken from the quarries of Nova Scotia and New Brunswick, and exported to the United States in 1851. This, according to Mr. Andrews, was 40,592 tons, and valued at $28,145. And in the year 1850, the quantity quarried reached the enormous amount of 79,795 tons.[1] According to Dawson, the quantity quarried in Hants and Colchester districts in 1851 was 78,903 tons, having a value of £10,000 at the ports of shipment, the greater part of which is exported to the United States for agricultural purposes.[2]

It is thus seen that there is an immense and inexhaustible supply of this valuable mineral in convenient proximity to all parts of the Atlantic coast of the United States. It is readily quarried at little cost, and can be loaded directly into vessels without land transportation. This is sufficient to show that the deposits of Texas and New Mexico cannot become valuable as a source of gypsum for export. The expense of quarrying in horizontal beds is greater than in vertical ones, where they are exposed in bluffs; and the distance of the Texas deposits from seaports will confine the use of the gypsum to its immediate vicinity.

Origin of the gypsum beds.—The origin of these great beds of gypsum has excited much speculation, and numerous hypotheses have been formed by different writers to account for their formation. Some suppose the thick beds to have a mechanical origin—they having been deposited at the same time with the adjoining strata, and in a similar manner. Their igneous origin was formerly advocated—the absence of stratification in some beds being regarded as evidence of their once melted or fluid condition, and of their intrusion between the strata, as volcanic rocks or lavas are found to traverse stratified deposits. The doctrine of the chemical character or origin of the deposits is now, however, very generally accepted. Although not now prepared to enter into a full investigation and consideration of this difficult subject, I would remark, that when in California, in 1853, I was led to some conclusions respecting the formation of gypsum beds, by the study of phenomena presented in the Tertiary strata of Ocoya or Posé creek, where beautiful seams of transparent and fibrous gypsum occur.

Veins and layers of oxide of iron, produced by infiltration, are found at that place; also large beds of the same substance where there had formerly been accumulations of fossils, their casts only being left in the firm oxide, while all the lime had been removed. Still further below we find layers of crystalline gypsum, presenting in their structure full proof of an origin subsequent to the deposition of the strata.[3] These conditions were evidently the result of the infiltration of acid waters downwards through the strata; the lime of the shells having been dissolved, and a simultaneous deposition of iron produced.

I am inclined to regard all the great beds of gypsum of the Gypsum formation underlying the Llano as formed by the percolation through the strata of water charged with free sulphuric

one of the most curious features of the mine. On close examination, it appears to be laminar and concentric, and to consist of layers of blue clay and gypsum. Now the whole formation of gypsum contains a small portion of clay, which gives it the greyish color; and it is probable that when that peculiar principle, whether crystallization, attraction, or electricity, which caused the aggregation of the particles of gypsum in greater purity and in a more crystalline state was in operation, one of its chief effects was to expel to the circumference all the particles of argillaceous matter previously mixed up with the gypsum; a process which would continue until either the crust itself opposed a resistance to the further action of this principle, or until two opposing spheres nearly came in contact with each other."

"Very fine crystals of selenite, and sometimes of a large size, are not unfrequently found in the fissures of the gypsum. They are used for the purpose of making the fine scagliola cement, and are consequently sold at a much higher price than the ordinary gypsum. The price of the fine alabaster is 5 Tuscan lires the 100 lbs. Tuscan at the quarry, or 8 if delivered in Leghorn." [Quart. Jour. Geol. Soc. Lond. vol. i, p. 282.]

[1] Andrews's Report on the Colonial and Lake Trade: Washington, 1854, pp. 491 and 493.

[2] Acadian Geology, p. 238.

[3] Other interesting facts and observations upon the gypsum will be found in detail in the writer's forthcoming report of a Geological Reconnaissance in California.

acid, or with sulphate of iron, derived from the decomposition of pyrites. When such a mixture of acid and water passes downwards through the strata, and comes into contact with carbonate of lime, either disseminated in the strata or in the form of beds, it produces decomposition, and the sulphate of lime is formed, which crystallizes either at the place of decomposition, or at a still lower point, where the gypseous solution accumulates. This accumulation or concentration of the percolating fluid may be caused by the presence of a layer of impervious clay, which prevents its further progress. When the infiltrating fluid is charged with sulphate of iron, a double decomposition ensues, sulphate of lime and carbonate or oxide of iron being formed; the latter being deposited at the point of decomposition as a red or brown powder. The origin of the red marls and sandstones may be thus explained. I do not doubt the formation of many gypsum veins and thin layers in this manner—by the infiltration of acid water, and the subsequent and gradual crystallization of the solution in the strata, separating itself in clear plates from the earthy materials which hold the solution. This is accomplished by the crystalline forces, precisely as water in crystallizing in a bank of earth and sand will separate into clear sheets of ice with such tremendous force as to elevate banks of superposed earth many feet thick. If a thin seam of selenite or ice may be formed in this manner, it is not unreasonable to believe that beds many feet thick may have the same origin. A larger supply of material only is required. Abundance of lime for the formation of such beds would be found in the thick beds of limestone, or, disseminated with the sands and clays of the great mass of the strata. Whole beds of limestone may have been transformed from the carbonate to the sulphate. With respect to the sources of the sulphuric acid, its origin is indicated to us by the highly sulphurous nature of the water constantly being poured out on the surface of the Llano, or in the valleys of the streams on its borders. These waters contain much sulphuretted hydrogen in solution, which, on exposure to the oxygen of the air, becomes converted into sulphuric acid. These springs may have once been much more numerous and powerful, and may have been charged with free sulphuric acid. The water may either have risen to the surface, or permeated the strata from below. Another source of sulphuric acid may have been found there in entombed organic remains, which, by their decomposition, give rise to sulphuretted hydrogen.

I am pleased to find that Mr. Dawson also regards the action of free sulphuric acid upon beds of limestone as the probable cause of the formation of the gypsum beds. In relation to this subject, he makes the following observations: "For the gypsum of Nova Scotia, occurring, as it does, in thick and extensive beds, interstratified with marl and limestone, there appears to me to be but one satisfactory theory—that of the conversion of beds of calcareous matter into sulphate of lime by free sulphuric acid, poured into the sea by springs or streams issuing from volcanic rocks. Modern volcanoes frequently give forth waters containing sulphurous and sulphuric acid. In the volcanic region of Java, for instance, there is a lake of sulphuric acid, from which flows a stream in which no animal can live. The water of this stream being, probably, more dense than sea-water, will naturally flow along the bottom of the sea, and, if it meets with beds of calcareous matter, will convert them into gypsum."[1]

IV. LEAD.

Lead and silver mines of the Organ mountains.—Description of the specimens.—Galena.—Cerusite.

I find several large and fine specimens of lead ores in the collection, but they are without labels. In Captain Pope's Report, however, mention is made of "valuable silver and lead mines" on the west side of the Organ mountains, "extending over a continuous distance of twenty-five miles."[2] He also states that specimens from these mines were obtained and brought in. I therefore conclude that the specimens are from the above locality.

As our knowledge of these mines is so limited, and every fact concerning them is of the

[1] Acadian Geology, pp. 223, 224.

[2] Report of Captain Pope, p. 31.

greatest interest, especially in connexion with the analyses of the ore, I quote the observations upon the locality given in the Report:

"The want of means to open these mines, and the ignorance of mining characteristic of the New Mexican, have altogether prevented any development of their richness; and it has only been within the last eighteen months that anything like a serious commencement has been made. Mr. Stevenson has opened a mine about fifteen miles from the river, at Doña Ana, and, notwithstanding the impossibility of getting an experienced miner, and the crude and imperfect manner of smelting he has been compelled to adopt, the results have been exceedingly profitable. The ore is powdered between two stones, and the smelting is done without one convenience common to the States. The refuse, probably, contains as much silver as the original ore; and, notwithstanding this, from a mule-load of three hundred pounds of the ore, he gets $18 of silver."[1]

These descriptions will apply to a silver mine rather than to one of lead. The specimens brought in are of lead, and contain but a small portion of silver. It is, however, possible that there is a large quantity of loose friable ore in connexion with the more compact masses, such as Captain Pope obtained, and which is much more rich in silver. Silver is a common associate of lead ores, especially of galena, with which it is so combined that it is generally separated by smelting and cupellation. The following is the description of the specimens:

No. 78. *Galena, from Organ mountains?*—The specimen is a very fine mass of galena, (a sulphuret of lead,) and it contains a small nodule of iron pyrites, and some fragments of carbonate of lead. Galena, when pure, consists of—

Sulphur	13.4
Lead	86.6
	100.0

It crystallizes in cubes and in modifications of the monometric system, the cleavage of which is very distinct in the specimens. This ore of lead generally contains a small quantity of silver, and the specimen is labelled "argentiferous." The specimen was examined by cupellation to determine the quantity of silver. An average of three trials yielded 0.165 per cent., or 48 troy ounces to the ton. It yielded 85.62 per cent. of lead.[2]

No. 79. *Cerusite, (specimen marked "Plomb argentifere,") from the same locality as No.* 73.—This is a mass of compact carbonate of lead, containing some small cavities in which the crystalline planes of the mineral can be seen. The amount of lead was determined as sulphate, giving 72.48 per cent. of the metal. An examination was made for silver, but not a trace could be found.

Carbonate of lead is known in mineralogy under the name of *cerusite*, and, when pure, has the following composition:

Carbonic acid	16.5
Oxide of lead	83.5
	100.0

This mass is remarkably large, and shows that very considerable deposits of ore exist at the locality from which it was taken. The mineral has resulted from the decomposition of the vein, which probably consists of the sulphuret. It is a very valuable ore of lead, and is very easily

[1] Report of Captain Pope, p. 31.

[2] The examination of these specimens for silver was made for me by Doctor J. D. Easter, of Baltimore.

smelted. This mineral is found in beautiful crystallizations at the Wheatley mines in Chester county, Pennsylvania. It also accompanies the ores of lead in Cornwall and Alston Moor, England, and in Scotland at Leadhills and Wanlockhead.

V. SULPHUR.

Analysis of a powder from Delaware creek.

No. 71. *A greenish earthy powder, from the bed of Delaware creek, at the springs.*—This specimen contains 18.28 per cent. of free sulphur; the residue consisting of sand and clay, with other earthy ingredients in small proportions. The determination was made by igniting a weighed portion, previously dried at 212°, in a porcelain crucible.[1]

An aqueous extract contains:

Alumina and oxide of iron, lime, magnesia, and sulphuric acid.

This quantity of sulphur is sufficient to render the earth very valuable; but its distance from water-transportation and a market is so great, that it probably will not be available even if found in large quantities. From the chemical examination of the waters of the spring by Dr. Booth, it appears that chloride of sodium (salt) is the principal solid ingredient, but considerable quantities of sulphide of sodium are present, and in one the amount was considered equal to the quantity of salt. The water also contains carbonate of soda and sulphates of lime and magnesia.[2] It is probable that the waters, as they issue from the springs, become changed, and their ingredients undergo recomposition on exposure to the air or by mingling together. The waters from the springs examined by Dr. Booth were alkaline, but it is possible that some of the springs are acid; and in this case the precipitation of sulphur would ensue on the mixture of the acid waters with those charged with the alkaline sulphurets, and the origin of the deposit of sulphur in powder would thus be explained.

[1] This examination was made for me by Dr. J. D. Easter, of Baltimore.

[2] See Table III, "Mineral Waters," p. 97 of Captain Pope's Report.

CHAPTER VI.

Description of the Fossils collected by Captain John Pope.

EXOGYRA TEXANA?

No. 80. *From the banks of Red river, near Preston.*—This specimen is labelled *Ostrea carinata*, from the "*Neocomian*," but consists of a confused mass of fragments of fossil shells, in which the specific characters are completely lost. Traces of plication are visible on one of the edges of the specimen, but they are not sufficiently well defined to permit of a determination of the species. They are not so sharp and angular as in *O. carinata*, but are more rounded, and more nearly resemble the plications of *Exogyra Texana*. If it were possible to identify *O. carinata* in this specimen, it would indicate a Cretaceous age for the deposit, for this species is characteristic of the Lower greensand, Upper greensand, and Chalk marl—the three divisions of the Cretaceous. Its occurrence, therefore, cannot be regarded as an evidence of the Neocomian age of the deposit from which it was taken.

No. 84. *From Big springs of the Colorado.*—This lot consists of three specimens of *Exogyra Texana*, Roemer,[1] a fossil species common in the Cretaceous formation of Texas. It has been obtained by Dr. G. G. Shumard, at the Cross Timbers, Texas,[2] and by Dr. Roemer, in the Cretaceous deposits near Fredericksburg and New Braunfels.

No. 85. This specimen appears to be a valve of *Exogyra Texana*, but it is much worn, and no label was appended showing the locality.

GRYPHÆA.

No. 83. *From the Big springs of the Colorado.*—This lot of shells consists of four specimens of *Gryphæa Pitcheri*, Mort. They are rather small, but are well characterized, and indicate a Cretaceous age for the formation. One of the specimens contains, among fragments of shells adhering to its interior, a portion of a shell resembling a *Pecten*, but its specific character cannot be recognised.

No. 81. This specimen is labelled "Outcrop of horizontal strata, 20 miles east of the Sand hills, on the Llano Estacado." It is also said to form the highest stratified rock. Like No. 80, it consists of a confused mass of fragments of shells, but their characters are more distinct, and *Gryphæa* can be easily recognised. It is, however, not possible to determine the species, but it is probably *G. Pitcheri*.

Nos. 86, 87, 88, 89, *and* 90. *From the Big springs of the Colorado.*—These specimens are granular limestone, friable and porous, and of a light-drab or buff color. They are said to be taken from the base and top, and the intermediate portions of the bluff at the springs. One specimen, from near the base, is more compact than the others, and contains a large amount of crystallized carbonate of lime in little seams. Specimen 89, from near the top of the bluff, contains a small *Gryphæa*, which resembles *G. vomer*, but it is not well enough preserved to be identified. This is the only fossil that can be detected, but the formation may be regarded as Cretaceous.

[1] F. Roemer, Texas, 396; also, Roemer's Kreid. Tex., 69, Taf. x, fig. 1, a–c.

[2] Marcy's Report—Appendix E, 205.

In the letter of Charles L. Taplin, addressed to Captain Pope, mention is made of ledges of petrified oyster-shells from this locality.[1]

No. 82. *A specimen labelled "Neocomian limestone from the Elm fork of the Trinity river."*—It consists of fragments of *Gryphœa*, firmly impacted together, and so obscure that the species cannot be determined. It resembles *G. Pitcheri*, and in the mineral characters so closely simulates specimens obtained by Major Emory, and containing Cretaceous fossils, that it must be regarded as coming from the same formation. There is certainly no evidence of its being of the age of the Neocomian division.

PRODUCTUS.

No. 91. *From the bed of an affluent of the Elm fork of the Trinity river.*—These two specimens are compact limestone, of a dark color, and much stained with oxide of iron. They are marked by casts of fossils, which, though obscure, are of Producti, and indicate, for the specimens, the age of the Carboniferous. They are, undoubtedly, transported fragments from outcrops of the Carboniferous limestone.

REMARKS.

The fossils which Captain Pope has collected, with the exception of No. 91, are all such as characterize the Cretaceous formation. This formation is well represented by *Gryphœa Pitcheri* and *Exogyra Texana* from the Big springs of the Colorado. These fossils are well known in the Cretaceous formation of Texas. The former was first described by Dr. Morton, of Philadelphia,[2] who received his specimens from the plains of Kiamesha, Arkansas. He also states that he has seen other specimens from the falls of Verdigris river, in the same territory.

These fossils serve to indicate the development of the Cretaceous formation at the following points: Banks of the Red river, near Preston; Big springs of the Colorado; Elm fork of the Trinity river; and a point twenty miles east of the Sand hills, on the Llano Estacado. I have therefore colored these places as Cretaceous upon the map.

[1] Report of Captain Pope, p. 77.

[2] Morton's Syn. Org. Rem. Cret. Groups U. S., p. 55.

U.S. PACIFIC RAIL ROAD EXPLORATION & SURVEY
WAR DEPARTMENT

GEOLOGICAL MAP

OF THE

Route explored by Capt. J.no POPE Corps of Topl. Engrs
Near the 32nd. Parallel of North Latitude
1854

FROM THE RED RIVER TO THE RIO GRANDE

Prepared in the Office of Pacific Rail Road Exploration & Survey, War Department
By William P. Blake

Statute Miles
Scale of 1:3000000

INDEX OF COLORS

1 Granitic & Metamorphic
2 Carboniferous Limestone
3 Carboniferous Sandstone
4 Cypress Formation
5 Cretaceous

LLANO ESTACADO

GULF OF MEXICO

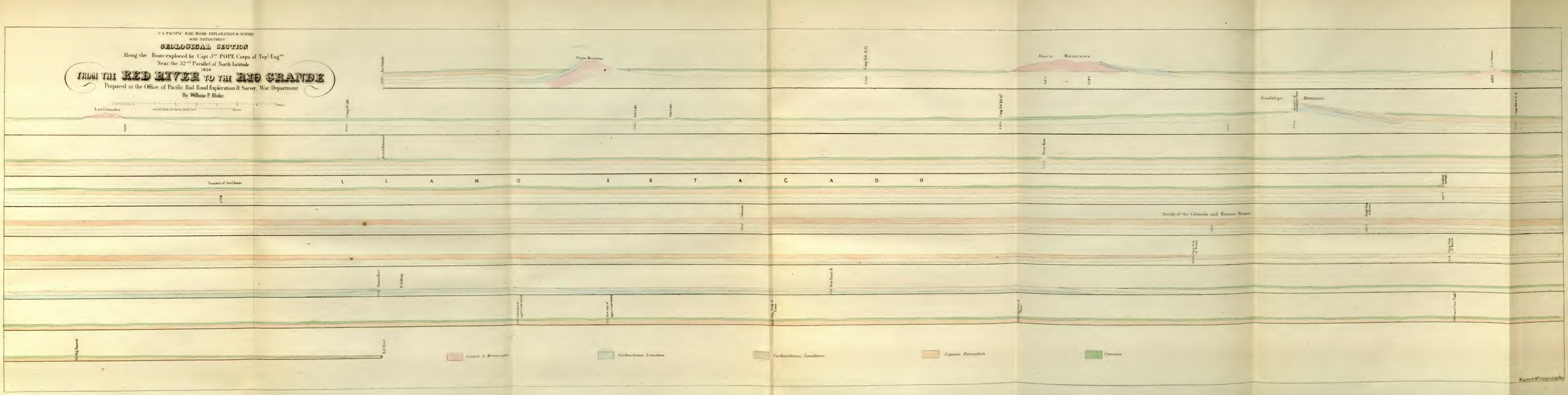
U.S. PACIFIC RAIL ROAD EXPLORATION & SURVEY
WAR DEPARTMENT

GEOLOGICAL SECTION

Along the Route explored by Capt J.^me POPE Corps of Top.l Eng.^rs
Near the 32.nd Parallel of North Latitude
1854

FROM THE RED RIVER TO THE RIO GRANDE

Prepared in the Office of Pacific Rail Road Exploration & Survey, War Department
By William P. Blake.



CATALOGUE

OF

THE GEOLOGICAL COLLECTION

MADE BY

BREVET CAPTAIN JOHN POPE, 1853.

I.—ROCKS AND MINERALS.

No.	Name.	Locality.
1	"Carboniferous limestone"	Mesilla valley.
2	Limestone, "probably Carboniferous." (2 specimens)	Organ mountains.
3	Granite and limestone. (4 specimens)	Hueco Tanks, from different parts of the mountain.
4	White granular earth	Ojo del Cuerbo, west side of Guadalupe mountains.
5	Limestone	Head spring of Delaware creek.
6	Limestone	West and south side of Guadalupe peak.
7	Transparent selenite	Do. do.
8	Dark limestone	Guadalupe mountains.
9	Compact sandstone	Do.
10	———?	Found near Ojo de San Martine, (head waters of Delaware creek.)
11	Limestone	Ojo de San Martine.
12	Gypsum	Do.
13	Gypsum in layers	Banks of Delaware creek.
14	Gypsum in layers and plates	Delaware creek.
15	Red fibrous gypsum	Do.
16	Limestone ("*Jurassique*")	Independence springs, Delaware creek.
17	Compact, white, granular limestone	Foot of the Guadalupe mountains.
18	Reddish sandstone	12 miles below Delaware creek, east side of the Pecos—large masses.
19	Grey sandstone	Pecos river, near its banks.
20	Coarse-grained grey sandstone, with pebbles—calcareous.	Pecos river, (mouth of Delaware creek.)
21	Limestone of a light-drab color, with small spherical cavities.	Came with No. 20.
22	Pebbles of agate quartz and red porphyry	Bluffs along the Pecos, March 20, 1854.
23	Sandstone, reddish and coarse-grained—calcareous	Bluffs along the east bank of the Pecos, March 20, 1854.
24	Large pebble and coarse grains of sand cemented by a calcareous matrix.	Bluffs east side of the Pecos.
25	Selenite, (rough crystal)	Pecos river, east side.
26	White calcareous sandstone	10 miles from Pecos river, direct route, Llano Estacado.
27	Sandstone, brown, compact and hard	East side of Pecos river, 20 miles from the mouth of Delaware creek.
28	Red sandstone, fine-grained	East side of the Pecos river, 24 miles below the mouth of Delaware creek.
29	White calcareous sandstone, containing much carbonate of lime.	Surface of the Llano Estacado, 40 miles east of the Pecos.
30	Grey sandstone	Llano Estacado, 41 miles east of the Pecos.
31	Limestone, greyish-white, amorphous	Outcrop on the Llano Estacado, 40 miles east of the Pecos.
32	White flint, with reddish seams and grains disseminated.	Llano Estacado, 50 miles east of the Pecos river, direct route.
33	Calcareous mass	10 miles east of the Pecos, (Marcy's trail,) March 24, 1854.
34	Calcareous mass, resembles 33	Surface of the Llano Estacado, direct route.
35	Mass of pebbles, incrusted and cemented by carbonate of lime.	Llano Estacado, 11 miles east of the Sand hills; March 27, 1854.
36	Hard calcareous sandstone, brownish red and very compact.	Llano Estacado, 13 miles east of the Sand hills; March 27, 1854.
37	Limestone, fossiliferous; resembles 31, and has casts of shells, probably *Gryphæa*.	Llano Estacado, about 15 miles east of the Sand hills; March 27, 1854.

No.	Name.	Locality.
38	White calcareous sandstone	From the bluffs between the Big springs and Sulphur springs of the Colorado.
39	Silicious and calcareous mass, white, and containing a seam of semi-opal.	Sulphur springs of the Colorado.
40	Amorphous opaque mass, chiefly carbonate of lime.	Between Mustang springs and Big springs of the Colorado.
41	Compact calcareous sandstone. The grains are in a firm investment of carbonate of lime.	Cedar bluffs, ledge between Mustang springs and Big springs of the Colorado.
42	Compact and fine-grained red sandstone	Bluffs below the Big springs of the Colorado. (Horizontal strata.)
43	Mass of pebbles cemented by oxide of iron	Big springs of the Colorado.
44	Nodular concretion, sand and oxide of iron	Near Big springs of the Colorado.
45	Flint stained with oxide of iron	Vicinity of the Ojo del Cuerbo. (Crow springs.)
46	Sandstone charged with oxide of iron	Llano Estacado, east of White Sand hill.
47	Sandstone	Head waters of the Colorado, 25 miles from the Sulphur springs.
48	Gypsum and sandstone	Red fork of the Colorado river.
49	White sandstone, (similar to 41—"Carboniferous.")	Cross Timbers of the Trinity river.
50	Limestone, light-drab color, and compact	Head waters of the Clear fork of the Brazos.
51	Conglomerate, silicious	Affluent of the Trinity.
52	Sandstone, compact, fine grained, and light-grey color, calcareous.	High bluffs of the Brazos.
53	Sandstone, two specimens, grey and red	Head waters of the Colorado, 20 miles from the Sulphur springs, being the lower strata of a bluff on a ravine.
54	Flint nodule	Dividing ridge between the Colorado and Brazos.
55	Limestone	High bluffs, head waters of the Brazos; horizontal strata.
56	Sandstone, highly charged with iron, hard and heavy.	Between head waters of the Colorado and the Brazos.
57	Conglomerate, charged with iron like 56	Same locality as 56.
58	Flint	Clear fork of the Brazos.
59	Red sandstone, fine grained, and compact	Head waters of the Colorado.
60	Grey and reddish sandstone	Do.
61	Grey sandstone, compact	Between Clear fork and the Brazos.
62	Gypsum	Head waters of the Brazos.
63	Sandstone	North side of the Brazos.
64	Limestone of a blueish color, containing on one side pebbles of red and white quarta.	Head waters of the Brazos.
65	Sandstone and gypsum	Head waters of the Brazos river.
66	Argillaceous sandstone	Near Clear fork of the Brazos, in a ravine.
67	Limestone	Tributary of the Brazos.
68	Red and grey sandstone, three specimens	Bluffs on the head of the Brazos river.
69	Ferruginous sandstone, full of almond-shaped cavities	From the vicinity of Fort Washita.
70	Silicified wood	Cross Timbers of the Upper Trinity.
71	Sulphur	Bed of Delaware creek at the springs.
72	Porous friable rock	Bed of Salt lake, 15 miles east of the Guadalupe mountains.
73	Trachytic rock	Near Los Cornudos.
74	Limestone and ———	Sierra Alto.
75	Limestone and sandstone	Head waters of the Colorado.
76	White limestone and sandstone	25 miles east from Sulphur springs, March 23, 1854.
77	Sand	Sand hills, west side of the Guadalupe mountains.
78	Galena	Organ mountains.
79	Cerusite, carbonate of lead	Do.

II. FOSSILS.

No.	Name.	Locality.
80	Mass of broken shells, probably *Exogyra Texana*	Banks of the Red river near Preston.
81	Mass of shells, consisting of fragments of *Gryphæa*	Llano Estacado, 20 miles east of the Sand hills.
82	Mass of fragments of *Gryphæa*	Elm fork of the Trinity, high ridge outcropping from the surface.
83	*Gryphæa Pitcheri*, four specimens	Big springs of the Colorado.
84	*Exogyra Texana*, three specimens	Do. do.
85	*Exogyra Texana*, much worn	No locality given.
86	Several specimens of a drab-colored limestone, containing *Gryphæa* like *G. vomer*.	Big springs of the Colorado, from different parts of the bluff.
91	Carboniferous limestone, two specimens, (boulder)	Affluent of the Elm fork of the Trinity.

NOTE

IN

EXPLANATION OF THE MAP AND SECTION.

The Geological Map which I have prepared to accompany this Report exhibits the line surveyed by Captain Pope, with its relations to the Mississippi river and the shore of the Gulf. The scale is the same with that of the *General Map* of the United States Territories now in preparation in the Office of the Pacific Railroad Explorations and Surveys. The ranges of mountains are indicated by a broken line, instead of the ordinary shading used by topographers. The width of the map has been made to correspond with the quarto page, so that it need not be folded in more than one direction.

The section is drawn to an equal scale for heights and distances, or half an inch to the mile. The direction of the section corresponds with the line of survey as marked on the map, except the extreme western end, which follows the parallel of 32° of latitude from the Rio Grande river to the Hueco mountains, where they are crossed by the trail.

The western portion of the section is nearly transverse to the trend of the mountains and the strata, and therefore gives a true representation of the strata, so far as they are known. The eastern portion, however, is believed to be nearly, or approximately, parallel with the trend of the Carboniferous rocks near Fort Belknap, and the direction of their dip cannot, therefore, be shown with any accuracy. In coloring this section, I have distinguished between the Cretaceous rocks of the surface of the Llano, and the subjacent red marls, clays, and sandstones which contain the gypsum. They are also distinct from the Carboniferous, although it is my opinion that further investigations will connect these strata with one of the two formations, probably with the former, if they are found to be unconformable in the Guadalupe Pass and at other places. In either case, the separate coloring is desirable, as there is sufficient difference of mineral characters to authorize a division for convenience of description, even if the strata are not separable by a difference in their organic remains.

Tertiary strata are not represented upon the Llano and the plains beyond, for the reason that there is no evidence of their presence. It is probable, however, that they occur either on or near the line of survey, but they may have been entirely removed by denudation. The detrial accumulations, or the wash and debris from the mountains, are also unrepresented. It is probable that they are quite thick about the mountains, and especially at the base of the Organ and of the Hueco mountains; and they may extend over a great part of the plains between the ranges, so as to hide the older formations—the Tertiary or Cretaceous—from view. In representing the upper or light-colored strata of the Llano—and, indeed, all the formations—it was found desirable to distort them in thickness, so that their relations would be more apparent to the eye.

It is, of course, impossible to represent accurately the position and thickness of strata underlying the surface, and which are not exposed at short intervals, by sections. The section, and especially that part representing the Carboniferous rocks below the surface, is to a great extent ideal, and is not presented as accurate, but will, it is hoped, serve the purpose of giving a

general view of the relations of the strata, until further and more extensive explorations furnish the material for a better representation. The Carboniferous limestone is represented as dipping eastwardly from the Hueco mountains; but as there are no observations respecting an outcrop further east until the Guadalupe range is reached, I have not brought it to the surface in the section, but terminated it at the base of the granite outcrop of the Alamos.

As there is no mention of the occurrence of Carboniferous strata on the east slope of the Organ mountains, nor on the west of the Hueco range, I have not represented them on the section between those ranges.

Since the section was finished, I have learned from Dr. Antisell that the Carboniferous limestone of the Organ mountains is overlaid by a sandstone, which is probably of the same age. I did not venture to bring it to the surface in the section, although confident it was present below.

It was deemed so desirable to have the whole section on one sheet, of a width not greater than the quarto page, that the spaces between each line were contracted as much as possible. It is hoped that the explanation will be a sufficient excuse for the crowded appearance of the sheet.

INDEX

TO THE

REPORT ON THE GEOLOGY OF THE ROUTE

NEAR THE THIRTY-SECOND PARALLEL.

A.

	Page.
Acadian Geology, by J. W. Dawson	26
African deserts, wells in	15
Alabaster	18, 32, 34
Andes, gypsum of	18
Andrews, J. D., quoted	35
Anhydrite	18, 33, 34
Apaches	13
Armarillo creek	9
Artesian wells	22—23

B.

Bartlett, J. R.	13
Bastrop, coal at	32
Beyooda Desert	15
Big Plaster rock, N. S.	18
Big Springs of the Colorado	17, 21
Bituminous coal	27, 31
Bluffs, on Red river	9, 10
Llano	9, 10
Booth, Professor	21, 38
Boulders	13
Boundary Commission	12
Bryan, Lieutenant, quoted	13
Building stone	29—30
Byrne, J. H., quoted	12, 13, 19

C.

Canadian river	9
Cathedral rock	14
Carboniferous limestone	12
of Guadalupe mountains	14
near Fort Washita	25
fossils of Windsor, N. S.	26
suitable for buildings	29
Carboniferous sandstone	25
Carboniferous strata, containing gypsum	18, 26
Carbonate of lead	37
Castellina, Tuscany, gypsum at	18, 34

Page.

Caves, in gypsum 16, 18
Ceriopora 26
Cerusite 37
Coal 27, 31
Colorado Desert 14, 19, 29
Conglomerate, silicious 30
Conularia 26
Cretaceous 17, 19, 25, 27
at Doña Ana 17, 19
fossils ..... 17, 27, 39—40
of Alabama 25
between Fort Belknap and Preston 27
Crow Spring 20, 21
Cross Timbers 27
Cyathophyllæ 32

D.

Darwin, Charles 18, 26
Dawson, J. W 18, 26
Delaware creek 21
Des Moines, gypsum of 18
Doña Ana 17
silver mine near 37
Drifting sand 20
Drift 16, 21

E.

Easter, Dr. J. D 37, 38
Efflorescence of salt 20
Emory, Major W. H. 12, 17, 40
Encrinites 32
Exogyra Texana 17, 27, 39

F.

Fenestella 26
Ferruginous sandstone 29
Fort Washita, Cretaceous at 25
Fort Belknap 24, 25
section of strata at 27

G.

Galena ..... 36—37
Garrard, Lieutenant 7, 22
Geological section, note on 42
Geological map, note upon 42
Granite 8, 12, 13, 14, 30
for building purposes 29, 30
Gray, A. B. 14
Great Basin 9
Gryphæa 17, 27, 39, 40
Guadalupe mountains, extent and direction of 7
elevation of 8
geology of 14
water at the base 22
Guadalupe Pass, elevation of 8
Gypsum formation 16, 17, 18, 19, 25, 34
of South America 18, 26
of Nova Scotia 18, 26

	Page.
Gypsum formation, of Italy	18
extent of	19
boundaries of	25
age of	25, 26
on the Canadian river	34
of Plaister Cove, N. S	34
Gypsum, on Red river	16
on Delaware creek	16, 18
of the Andes	18, 26
of Iowa	18, 26
of Nova Scotia	18, 26
fibrous	18
used as glass	18
quantity of	25
composition and characters	32
at Plaister Cove, N. S	34
quantity exported to United States	35
origin of	35—36
in California	35

H.

Hamilton, W. J	18, 34
Helix	28
Hitchcock, Professor	25, 31
Hueco Pass, elevation of	8
Hueco mountains	8
geology of	12
Hueco Tanks	15
Hurrah creek	9

I.

Independence Springs	21
Iowa, gypsum of	18
Italy, gypsum beds of	18

J.

Jurassic	17—18, 25

L.

Los Cornudos	13, 15
Lead	36, 37
argentiferous	37
Lignite	31
Limestone, crystalline	12
carboniferous	12, 14, 26, 27
for buildings	29, 30
Lime, caustic	27, 30
Llano Estacado, description of	8
elevation	8, 9
undulations	8
extent	9, 10
rivers and streams	10
bluff borders	10
geology	16, 17
fossils	17
sandstone	17
possibility of obtaining water on, by boring	22
building stones	30

Page.

Loess, of Red river 28
of the Mississippi and the Rhine 28
Loomis, Colonel G. A 27, 31
Lower Cross Timbers 27
Lymnea 28

M.

Map of the route, note on 42
Marcy, Captain R. B 9, 10, 12, 32
Marcou, Jules 17, 25, 26
Marshall, Lieutenant 16
Mesa 8
Metamorphic rocks 12
Mezquit timber 24
Mineral waters 21, 38
Mines, of alabaster 34
of lead 36
Mississippi, ancient alluvium of 28
Moore, Dr., of Texas 32
Mustang Springs 21

N.

Nova Scotia, gypsum 18, 26

O.

Oak openings 24
Ocoya creek, gypsum of 35
Ojo del Cuerbo 8, 20, 21
Organ mountains 7, 12
trend of 7
lead in the 36
Origin of beds of gypsum 35
Orthoceras 26
Ostrea carinata 39
Owen, Dr. D. D 18
Oyster shells, ledges of 40

P.

Pecos river 9
Permian 25
Phengites 34
Physical geography, remarks on 7
Physa 28
Plains between the Rio Grande and the Guadalupe mountains 19
Plaister Cove, N. S 26, 34
gypsum of 18
Planorbis 28
Plaster of Paris 33
Pleurotomaria 32
Polished rocks, at the Hueco Tanks 14
on the Colorado Desert 14
Pope, Captain, quoted 18, 19, 24
Preston 25, 28
Preston Salt Valley, Virginia, gypsum 18
Productus 26, 27, 32, 40
Pupa 28

R.

Red river 9
Reservoirs of water in the deserts 15

	Page.
Rhine, loess of	28
Rivers and streams of the Llano	10
Rocky Dell creek	9
Rogers, H. D	18
Roman pearls	34

S.

Sacramento river, gypsum on	16
Saline lakes	20, 21
of California	21
Sand hills	19
of the Colorado Desert	19
water among	20
Satin spar	32, 34
Section of the Llano	16
of strata at Fort Belknap	27
note on	43
Selenite	16, 18, 32, 33
Shubenacadie, gypsum	18
Shumard, Dr. G. G	16, 25, 31
Silver, in lead ores	37
Sierra Alto	15
Sierra de los Alamos	8
Snow	15
Soil, along the Brazos	27
Spirifer	26
Springs	10, 21
at the borders of the Llano	23
Staked plain	24
Stevenson, Mr	37
Sulphuric acid	21, 36
Sulphide of sodium, in the water of springs	21
Sulphur	21, 38
Sulphur Springs	10, 21
Sulphurous lakes	20

T.

Table lands	8
elevation of	8
Tanks of water	12, 13, 15
in African deserts	15
Taplin, Charles L., quoted	40
Taylor, Bayard, quoted	15
Terebratula	26, 32
Tertiary	17, 19, 28
fossils of Tuscany	18
conglomerate of the desert	20, 29
drift of the Llano	21
reason for not representing it in the map and section	43
sandstone of the Bernardino Sierra, California	29
coal in	31
Texas, Tertiary coal in	31
Thorne's wells	14
Trap rock	12
Trias	17, 25
Trinity river, Cretaceous on	40
Tuomey, Professor	25
Tuscany, gypsum	18

U.

Page.
Upper Cross Timbers 27

W.

Water among the Sand hills 20
in natural tanks 15, 22
salt 20
springs 21
at the base of Guadalupe mountains 22
in the strata of the Llano 23
mineral 21, 38
Wheatley mines, cerusite at 38
Whipple, Lieutenant A. W. 9
Windsor, Nova Scotia, gypsum of 26
Witchita mountains 8

REPORT

OF

EXPLORATIONS FOR THAT PORTION OF A RAILROAD ROUTE,

NEAR THE

THIRTY-SECOND PARALLEL OF NORTH LATITUDE,

LYING BETWEEN

DONA ANA, ON THE RIO GRANDE,

AND

PIMAS VILLAGES, ON THE GILA.

BY

LIEUT. JOHN G. PARKE,

CORPS TOPOGRAPHICAL ENGINEERS.

REPORT.

Instructions from the Secretary of War.—Organization of party.—Route from San Diego to Pimas villages.—Pimas and Maricopas Villages, and Indians.—El Picacho mountain.—First appearance of cotton-wood after leaving the Gila.—Tucson; its inhabitants and their occupation.—Meteorite found in cañon of Santa Rita mountains.—Its analysis by Prof. Charles U. Shepard.—Attentions received from commanding officers at Tucson.—Country between the Tucson and San Pedro rivers.—San Pedro valley.—Dos Cabezas.—Playa de los Pimas.—Trails of Caballados.—Visits from Indians.—Characteristics of the valleys.—Cook's trail.—Ojo de Vaca.—Rio Mimbres.—Startling intelligence from Fort Webster.—Mesilla valley.—Mesilla.—Explanation of map.—Profile of country.—Timber.—Building-stone.—Water.—Barometrical measurements with reduced approximate altitudes.—Appendix.

WASHINGTON, D. C., *August* 22, 1854.

SIR: I have the honor to submit the following report of the operations of the party intrusted to my charge, for the examination and survey of railroad route to the Pacific, in obedience to the following instructions:

"WAR DEPARTMENT,
"*Washington, November* 18, 1853.

"SIR: The President of Mexico has given to this government authority to make surveys within the Mexican territory, in connection with examinations of railroad routes to the Pacific, and you are selected to make such a survey, in accordance with the instructions below, provided a suitable party can, as is believed, be organized with the means which will be placed at your disposal.

"For this purpose a draft on the assistant treasurer at San Francisco for five thousand dollars is herewith enclosed to you, and orders have been given to Lieutenant Williamson to supply you with all the funds he can spare, and all the animals, equipments, &c., which may be disposable for the object, on the disbanding of his party.

"A similar order has been given to Lieutenant Whipple, though it is hardly expected that aid from him will be necessary should these instructions reach you before the party of Lieutenant Williamson is disbanded. If, however, Lieutenant Williamson should have sold his animals and equipments, you may find Lieutenant Whipple's assistance essential to your success. It is to be distinctly understood that neither of those officers is to deprive himself of anything necessary to the prompt completion of his report. The organization and outfit of your party are to be completed on the most economical scale that can be prudently adopted.

"The necessary orders have been given for the detail of an escort, and supplies for the same.

"You will confer with Lieutenant Williamson upon everything relating to the organization and outfit of your party, and to your plans for the prosecution of the work.

"You will use the utmost despatch in commencing and prosecuting the duty assigned to you, and observe the following instructions in regard to it:

"Referring to a sketch from the office of the Mexican boundary survey, hereto annexed, you will commence the barometric levellings on the Gila, a little above 'Pimas village,' at a place marked 'Dry creek;' follow the line by 'Tucson,' thence by blue line marked 'Nugent's wagon trail,' to angle in red dotted line marked 'Brackish pools,' east of Salt lake.

"It may be that a shorter and better line exists from the point of departure on the Gila to the point on the San Pedro where blue line, or Nugent's wagon trail, strikes it. The mountains in that cut-off are described to be generally parallel to the river San Pedro, and the belief exists that a goood route can be found through them on the line indicated.

"From the point marked 'Brackish pools,' just east of Salt lake, as far east as the first stream marked 'Sienega,' along the dotted red line, a survey and line of barometric levellings has been carried by the Mexican boundary survey. But it would be well to make the survey continuously along the red and blue line eastwardly until it strikes Cook's wagon trail, and thence by the shortest distance and most practicable route to the valley of the Rio Bravo, to some point between 'Doña Ana' and 'Frontera,' eight miles north of El Paso.

"A more eligible and direct route from the region of the said Salt lake to the point indicated on the Rio Bravo may be found. If information or observation on the ground shall so suggest, you will not confine yourself to the wagon trail described, but depart from the line indicated at any convenient point.

"Bear in mind these wagon trails are faint, and not as broad or well marked as the great emigrant trail known as Cook's route, which, having been sufficiently explored, will not receive your attention. The levels have been carried continuously by Major Emory along the valley of the Gila, and it might facilitate the operations not to unpack the barometer until the party shall have reached the point of departure from the Gila.

"As the whole country between the Gila and the Rio Bravo embraced in the parallels of latitude 32° and 34° has been well covered with astronomical observations, it will probably not be necessary for you to impede your progress in checking the run of your work by elaborate astronomical observations. A sextant and chronometer, by which you can obtain your latitudes, will, it is believed, prove sufficient to check your work.

"The profile of the region traversed, showing the gradients which a road passing over it must encounter, is the information most wanted. It is therefore recommended that you take the barometric height at every point on the line to be surveyed which may be important in the elucidation of this subject.

"On reaching the Rio Bravo, it may add little to the expense of your party to bring it all the way in to the settlements on the Red river. If so, you will take some new route from Doña Ana, passing through the northern part of Texas, and make a barometric levelling of the same.

"Very respectfully, your obedient servant,

"JEFFERSON DAVIS,
"*Secretary of War.*

"Lieut. J. G. PARKE,
"*Corps of Topographical Engineers, San Diego, California.*"

These instructions, with passport accompanying them, were received in San Diego, California, December 20, 1853,* on my return from an examination of the Jacum Pass, made under orders from Lieut. Williamson, corps topographical engineers. After receipting to Lieut. Williamson for so much of his property, including instruments, as was serviceable and necessary, I commenced the organization and equipment of a party, but found it imperative on me to repair to San Francisco for the purpose of securing the services of an assistant, and procuring funds and additional instruments; in all of which I succeeded, with the exception of obtaining a mountain barometer, there not being a single one available in that section of the country. Having returned to San Diego and completed the outfit of the party, which numbered in all fifty-six souls, we took our departure from the quartermaster's depot on the afternoon of January 24, 1854. The party was organized as follows: Mr. Henry Custer, assistant and topographer; Dr. A. L. Heermann, physician and naturalist; Lieut. George Stoneman, first dragoons, commanding escort of twenty-eight men, and also undertook the duties of quartermaster and commissary of the expedition, in the discharge of which were employed eighteen men; five additional men assisted in carrying barometers and tripods.

From San Diego we followed the emigrant route known as the Southern, via Warner's rancho, in the coast range, across the Colorado desert, to Fort Yuma, at the junction of the Gila and

*See "A," in the Appendix.

Colorado rivers, and thence up the Gila to the Pimas villages. To Fort Yuma the road is good, and presents no obstacle to rapid transportation with wagons excepting a steep ascent in the mountains and occasional sands on the desert.

Up the Gila our route lay upon the left bank of the river, with the exception of a short distance, where we were forced to cross to its right bank, the river having, in the last few years, changed its bed, and now washes the base of the mesas, which it was impracticable to pass without much labor.

The road is not confined entirely to the river-bottom, because of the close proximity of the river to the mesas, which often forced it to cross over terminating spurs that jut out from the south, thus cutting off many deep bends of this sinuous river.

The travelling upon the mesas was hard and firm, whilst that in the bottom was generally heavy. We moved under favorable circumstances, there having been quite a fall of rain since the last party passed, which not only laid the dust, but hardened the surface of the roadway.

While on the Gila the great scarcity of grass and other forage was a constant source of anxiety, and caused much night travelling. The few patches of grass near the watering-places were cropped close by the herds of stock driven to the California market, and the mezquite-bean, upon which the emigrant almost solely depends for the existence of his animals, was now out of season; but by dint of great care and attention on the part of Lieut. Stoneman, taking advantage of every bunch of cane growing at the water's edge, and the sparse tufts of a dry bunch-grass found on the mesas at a distance from the roadside, we succeeded in reaching the first of the Pimas and Maricopas villages, with all our animals, on the 13th of February, having just crossed a jornada of thirty-eight miles, and camped by a rain-water pool, surrounded by a large area of dry bunch and salt grass, three hundred and ninety miles from San Diego. To rest our animals and give them an opportunity to feed, we remained in camp a day, and on the following day moved through the villages, camping near the point where the emigrant trail, turning southward, leaves the river-bottom. We had numerous visits from the Pimas and Maricopas. Their chiefs and old men were all eloquent in professions of friendship for the Americans, and were equally desirous that we should read the certificates of good offices rendered various parties while passing through their country.

In order the more fully to describe the country traversed, with a view of facilitating the solution of the question of practicability of constructing a railroad through it, I will first transcribe the journal of our operations, setting forth the general features of the country, which may possibly be of service to any whose duties should hereafter require, or interest dictate to visit this region, and then subtend a memoir showing the gradients to be overcome along the route travelled, as illustrated by the accompanying map and profile.

While in San Francisco I had the good fortune to meet Mr. Nugent, and am much indebted to him for a copy of his notes made during a trip across this country; and as his trail, as plotted upon a sketch sent me, so ill accords with his notes, (in one instance crossing inaccurately what I deem an impracticable ridge,) it is proper for me to remark that where I departed from the line indicated in my instructions, I pursued that which, on examination, presented the fairest prospects for, and least obstacles to, the construction of a practicable profile, bearing in mind its directness.

February 16, 1854.—On turning from the river we have to encounter a long stretch of about seventy miles where the finding of water is very uncertain, it being dependent upon the rains and seasons. As is found by experience to be most advantageous on setting out upon these jornadas, we started from camp, on the left bank of the Gila, about six miles above the Pimas, at 1 p. m., and after travelling 3.5 miles in the river-bottom, took a course tangent to the eastern base of the ridge on our right, and skirting a mezquite growth, interspersed with small patches of bunch-grass, extending southeastward from the Gila. As we progressed the road became hard and firm, leading over a gradually ascending plain of a red gravelly surface, destitute of all vegetation excepting the grease-wood and occasional mezquite. In the distance

on the right were low lost mountains, and on the left a low ridge, increasing in altitude towards the south. Camped at 11¼ p. m., upon the hard clay surface of the drain for this vast area, without water or grass, having made twenty-three miles.

February 17.—Started at sunrise, continuing on our general course south 35° east. In front are two gaps, separated by a peculiarly castellated mountain, El Picacho, rising abruptly from the plain, through the eastern one of which passes our road. During the morning a few scattering bunches of grass were seen on either side of the road, affording a happy relief to the painful monotony of this almost desert. The road, still hard and firm, continues up the smooth drain with an apparently uniform ascent to the eastern gap, which we reached at 1 p. m., and fortunately found some pools of rain-water, surrounded by quite a dense growth of mezquite. This gap is not a notch or depression in the crest of a continuous ridge, but an extension of the plain narrowed down by bare, rugged peaks of almost solid rock, rising abruptly from the plain. Leaving the gap at 5 p. m., we continued over the same character of country until 10 p. m., camping by the road-side without grass or water—distance twenty-eight miles.

February 18.—A smart shower aroused the camp at an early hour this morning. The teams were soon harnessed, and we were again on the road at daylight. On the clearing away of the clouds, we found ourselves travelling directly for a gap separating a low ridge on the west from one probably two thousand five hundred feet high at its terminus, and extending eastward until lost below the horizon. The summits of this ridge are whitened with this morning's fall of snow, which was confined to those high altitudes. El Picacho looms up, with its well-defined and angular profile, a most prominent landmark.

At half-past 9 we struck the sandy bed of a stream leading from the gap, and bearing towards the Gila in a northwesterly course. Crossing the bed, we turned the point of a low ridge on the right of the gap—made up of huge, shapeless masses of trachytic rock, with a few scattering argillaceous nodules—and found, a short distance beyond, another pool of rain-water; but there not being a sufficiency of grass, and finding that it increased in quantity and improved in quality as we advanced, we pushed on still further, following the valley of the dry stream, and camped about noon by a water-hole with abundance of grass and wood. We have here not only the bunch-grass, but also the grama, which, although dry, possesses a great deal of nourishment. The cotton-wood makes its appearance—the first we have seen since leaving the Gila.

From the river to the entrance of this gap there extends a plain of gradual and apparently uniform ascent towards the south, with a surface free from washes and deep drains, but studded with isolated peaks and ridges, (lost mountains,) which, seen from a distance, have the appearance of continuity, and impress the traveller with the idea of being in the centre of a vast basin surrounded by chains of mountains. The soil of this plain changes from a dry, ashen loam at the Gila, through a reddish argillaceous sand, to a gravel as we approached the ridges and peaks; and yields a growth of stinted artemisia and larrea, with mezquite in the low portions, and cereus giganteus, midst other varieties of the cactus, upon the uplands. Scattered patches of grass were found by the roadside. These mountains are of peculiar form and shape. Their serrated crests and faces, often vertical and cliff-like, surmounting the slopes of the debris, give the whole, particularly when aided by mirage, a semblance to the crumbling towers of a fallen castle. The rock is volcanic, vesicular, and of a reddish color, which throws over the ridges of the distant landscape quite a purplish tint, forming a pleasing contrast with the glare and reflection from the parched plain. Within this gap we find the deep sand-bed of a dry stream, whose banks and terraces increase in altitude as we ascend; being at camp from fifteen to twenty feet high, and extending back to the mountains on either side.

February 19.—Remained in camp to-day, and took repeated readings of the barometers.

February 20.—Got under way at sunrise. Seven miles of good road, through the mezquite growth adjacent to the stream-bed, brought us to Tuczon. In order to allay any fears and correct all misapprehensions on the part of the inhabitants with reference to our movements and probable connexion with the lawless expedition then on foot for the seizure of this country, we

halted the party outside the limits of the town.* Lieutenant Stoneman and myself rode in, and, on inquiring of the guard, found the comandante of the presidio, Captain Hilarion Garcia, and also the inspector of the troops of the State of Sonora, Captain Bernabé Gomez; to whom we made ourselves known, and, stating the object of the visit, presented them our passport. The party then moved through the town, and encamped about two and a half miles beyond on the bank of a clear running brook, with abundance of grass and wood.

February 21.—Remained in camp.—Rest and a good feeding of corn, which we fortunately can obtain, will be of great service to our animals, some of them already beginning to fail. Tucson (properly Tuczon) is a one-storied flat-roofed adobe town of about six hundred inhabitants, whose sole pursuit is agriculture; the much dreaded Apaches having interfered greatly with their pastoral occupation. They raise chiefly corn and wheat, cultivating about three hundred acres of rich soil by irrigation from a stream which has its source near the mission of San Javier del Bac, 8.5 miles to the south; and although it flows past our camp with a depth of one foot, and width of six feet, its waters nevertheless disappear a short distance below the town, either consumed by irrigation or absorbed by the sands. At sunrise the temperature of this stream was 62°, while that of the air was 32°. Timber is scarce in this locality, that used in building, a species of pine, being found in cañons and narrow gorges of the distant mountains; while the cotton-wood, willow, and mezquite, of the immediate vicinity, is barely sufficient for fences and fires. From the summit of a conical hill about half a mile to the west of Tuczon, a very extended prospect is presented. On our back trail El Picacho stands near the horizon's verge, with its fine proportions distinctly visible. To the north and northeast is Sierra Santa Catarina, high, rugged, and with numerous spurs, extending eastward to the San Pedro. South of east is the gap through which we pass, bounded on the south by Sierra Santa Rita, which extends around to the south point. In this direction lies the valley of San Javier del Bac. To the southwest and west are a series of "lost mountains." This conical hill is covered with angular fragments of scoriæ, varying in size from that of an egg to a cubic yard, more or less vesicular and compact. Descending the hill, an amygdaloidal volcanic earth is found overlying a mass of metamorphic limestone, much contorted. At the base is found a coarse-grained granite, and apparently a conglomerate of all the above ingredients, decomposed where exposed, giving the whole a whitewashed appearance. The commandant showed us two specimens of a meteorite found in a cañon in Santa Rita mountain, about twenty-five or thirty miles to the south of Tuczon. They are both used as anvils, and were lying, one in the presidio or garrison, and the other in front of the alcalde's house. That in the garrison is of a very peculiar form, being annular and somewhat like a signet ring of large dimensions, its exterior diameter being about three and a half feet, and interior about two, and weighs near 1,200 pounds. The other piece weighs about 1,000 pounds, and has an elongated prismatic form, serving well the purposes of an anvil, it being partially buried, and standing nearly two feet above the surface of the ground. By permission of the authorities our blacksmith undertook to cut off some specimens for us, in which he almost entirely failed, the metal being so tough and hard; still, by dint of two hours' hard work and the use of a cold chisel of the best temper, and a most weighty sledge, we procured a few small chippings, sufficient for the purposes of analysis. The fracture is crystalline, resembling that of cast-iron. It yields to the hammer, and has a clear ring not unlike bell-metal.

NOTE.—Having submitted a specimen of the above meteorite to Professor Charles U. Shepard, I received from him the following, bearing date July 31, 1854, in relation to its analysis: "I have already so far submitted a portion of it to examination as to become fully satisfied of its meteoric character. It contains nickel, phosphorus, and magnesia, in addition to the iron. Sulphur is not thus far evinced, though probably present. I should add silver also to the list of ingredients. Its specific gravity is 6.66, which is rather below the average; but, most unexpectedly, I find that its entire mass is finely amygdaloidal, with an earthy white mineral

See "B," in the Appendix.

analogous to a meteoric mineral that I described as forming the chief part of the Bishopsville (S. C.) meteoric stone. It is this feature that makes your iron entirely peculiar. To see this trait, you have only to polish a little surface, and etch with hydrochloric acid, when the surface becomes speckled over with the white earthy mineral, imparting to it a porphyritic character; but to see this *well*, will require the aid of a microscope.

"Large quantities of the white mineral remain undissolved after the solution of the main mass in the acid; and floating among the residuum may be seen also a dark gray flocculent matter, which I took to be the meteoric mineral I have named Dyslytite. Much of the white earthy mineral is thus seen to be in grains, perfectly rounded; some of which are transparent and resemble hyalite; other portions of them are milk-white and nearly opaque. These last are soft, and precisely resemble chladnite."

February 22.—Again got under way, starting about noon; but, instead of taking the emigrant route via the mission of San Javier del Bac to the Cienega de los Pimas, thereby making a great détour, travelling first south, and then due east, we took a course direct for the gap, there intervening apparently a smooth and uniformly ascending plain; camped without water, but an abundance of grass. The officers of the garrison, and Inspector General Gómez, accompanied us to the camp; thus adding another to the list of polite attentions and serviceable offices rendered us by these gentlemen, for which we are under many obligations.

February 23.—Soon after leaving camp this morning, we were compelled to diverge from our course, owing to the thick growth of cactus, and were finally compelled to cut a road through it. Reaching the emigrant road, we turned almost due east, and travelled over an undulating country, the swells increasing as we neared the entrance of the gap, where we encountered a cañon debouching from this pass and opening out into a broad drain or valley to the northwest. Entering this cañon we commenced its ascent, travelling through deep and heavy sand, alternating with contracted meadow patches, hemmed in by walls, approaching verticality, of irregular, shapeless masses of rock, generally of a metamorphic character; limestone, granite, copper-green, and a pudding-stone, all being found without any marked characteristics or apparent order of superposition. Camped at the first water, with grass and wood, having made 18.4 miles.

February 24.—Made an examination of the country adjacent to the camp, and found that this cañon is the main drain of the gap or depression, and that the slopes on either side are rough and broken up by deep ravines and washes. Our teams started at nine and a half, and were soon forced to the hills by the narrowing of the cañon, rendering it impassable for wagons without much labor bestowed on removing the obstacles. Avoiding this cañon by a rough and rugged road, we again entered the valley, and thus continued through long, smooth meadows, and over rough and steep pitches (fortunately not high) for nine miles, when we ascended the table-land on our left and commenced the approach to the divide, following a set of wagon-trails. On the table-land had a good road over a red gravelly soil of decomposed igneous rock, yielding a rich growth of grama grass, which, although not in season, is nevertheless very nutritious, being perfectly cured hay, standing as it grew. Camped near the divide between the waters of the Tuczon and those of the San Pedro, without water and but little wood, having made 13.5 miles.

February 25.—Last night was cold and squally, a rain setting in immediately after dark. Started early and soon made the summit of the divide, whence we had a view of the San Pedro valley—a dry, parched-looking plain, bounded on the east by a low, bare ridge, beyond which loomed up in the blue distance the Dos Cabezas, the most striking and prominent landmark in this region. The trail bearing too much to the south, we left it, and turning eastward descended to the San Pedro, where we camped. From the summit there is a gradual slope to the valley proper, or bottom, which we entered by an abrupt descent of about sixty feet. This bottom is bounded on both sides by an irregular zigzag step, much indented by deep washes, and is at this point about three miles wide. It is covered with a growth of grass, now dry and

crisp. The stream is about eighteen inches deep and twelve feet wide, and flows with a rapid current, at about twelve feet below the surface of its banks, which are nearly vertical, and of a treacherous miry soil, rendering it extremely difficult to approach the water, now muddy and forbidding. The banks are devoid of timber, or any sign indicating the course or even the existence of a stream, to an observer but a short distance removed. Made eleven miles.

February 26.—Started down the stream about two miles to the ford, Lieutenant Stoneman having despatched a fatigue party to improve it; but in spite of this and the great exertion of Lieutenant S., we had no little trouble in effecting a crossing. There being no trail leading eastward from the river, the party again encamped, while I started to examine the several gaps in the ridge on our front. Leaving the river-bottom, we followed up a lateral valley; but finding it narrowing as we advanced, becoming a tortuous dry sand-bed or arroyo, bounded by steep slopes, we took to the table-land; and after a few miles of rough riding reached the gap immediately to the east of our camp, and found it not only impracticable for our wagons, but presenting no advantages for our profile beyond the mere direction. We then skirted the western base of this ridge southerly, and found a cañon leading directly through it, with walls of rounded masses of granite, which formed in many places, also, quite a step-like bottom. Passing through this cañon, we continued on the east slope, southward, and found that the ridge terminated, leaving a very inviting and apparently feasible pass between it and the terminus of an overlapping ridge from the south. In this pass we found comparatively fresh wagon-trails. Returned by following these trails to the river, and thence down to camp, arriving at midnight with our mules broken down.

February 27.—Lieutenant Stoneman and myself examined the fourth gap on the north of those examined yesterday, through which I am now satisfied that Mr. Nugent must have passed. We found the approaches difficult and hazardous to attempt with loaded wagons, according well with Mr. Nugent's notes: "a succession of steep hills and rocky ravines."

From the river bottom to the base of this ridge extends a foot-slope, appearing as if once smooth and of uniform ascent, but now cut up into a perfect labyrinth of washes and gullies, ramifying and branching into a multitude of arms as we ascend. Returning to camp, I determined to take the gap through which we passed last night. Packing up, we followed the river until striking the wagon trails, then turned eastward up a large sandy ravine, and camped at sundown without water, but a sufficiency of grass. Made fourteen miles.

February 28.—Left the ravine near the mountains, the road leading over a smooth, rolling, prairie-like surface through the pass, the summit of which we reached at 11 o'clock. Before us lay an extended plain, in the middle of which is the Salt lake, Playa de los Pimas, and beyond this the Chiricahui ridge, with its lofty Dos Cabezas; to the north the massive Mount Graham, with an apparently continuous ridge extending northwestward till lost below the horizon. Between this ridge and that over which we have just passed there is a wide opening towards the mouth of the San Pedro, apparently a continuation of the plain Playa de los Pimas. To the north of the Chiricahui ridge is a wide gap between it and Mount Graham; and immediately to the south of the Dos Cabezas is a third gap, Puerto del Dado, which is very inviting, and, lying directly on our course, I determined to travel through it.

From the summit we had a perfectly smooth road over a reddish soil, covered with grass, and devoid of trees with the exception of a few scattering palmettos down to the Playa, which, at present, is a hard, smooth, and apparently level area of about fifteen miles in length by nearly ten in width, without a particle of vegetation, it being the perfection of sterility. These playas, in my opinion, have no outlet, and are so nearly level that the rain and drain waters are spread over a large surface; and there being but little absorption and very rapid evaporization, it is left smooth and baked. In some places it is much cracked, and covered by a nitrous efflorescence, which gives rise to the ordinary name for all like places—"Salt lake." On the Playa we crossed two very large trails leading from south to north, doubtless those of

Caballados, once the property of the Mexican ranchero, and now furnishing rations for the ruthless Cayoteros.

We commenced the ascent of the slope beyond, and camped at sunset without water, having made 25.5 miles. During the day parties were out hunting water, but returned unsuccessful; one party completely turning the southern end of the playa, where water is indicated upon the sketch, and another going in search of the "brackish pools" on its eastern margin.

March 1.—Got off at 1 a. m.; took a straight course for the point of the mountains, expecting to find water, in accordance with the statement of our guide, in a cañon to the right of the Dos Cabezas. Here again disappointment met us, and left us now the only alternative to reach the spring in the Puerto del Dado, for which we immediately set out, having at the same time parties penetrating the cañadas and valleys on our left, with, however, but faint hopes of finding that which our animals stood so much in need of. During the night we passed over a perfectly smooth but gradually ascending grassy plain; but while skirting the bases of the foot-slopes from the Dos Cabezas, it became, as we advanced, somewhat undulating, our trail crossing valleys and their divides. At 1 p. m. we reached the summit of the pass, beyond which we encountered really a rough country. Still continuing on our course, we crossed a great number of valleys and cañadas near their sources, having much difficulty with our wagons upon the steep descents and ascents. Finding the much desired water, we encamped in a small triangular valley with an abundance of grass and wood, about 2.3 miles from the summit. While crossing the divide a few Apaches made their appearance, showing themselves only to the rear of the train. Two or three of our men approached them, and were saluted with cries of "muchos amigos."

After a short parley they were satisfied of our peaceable disposition, and followed us into camp. Made to-day twenty-three miles—in all, without water, fifty-five miles.

March 2.—Remained in camp to-day; took hourly observations of the barometer. The weather was cold and disagreeable, with raw and high winds coming down from the summits to the southeast of us. Our animals are now doing well, having an abundance of fine grama grass, and, by husbanding, a sufficiency of water. The spring is situated near the head of a lateral cañada, about five hundred yards from camp. The water is cool and good-tasted, but unfortunately the supply is limited, the small basin being emptied last evening before our mules were satisfied. Happily there is another in a valley near by, which was shown us by the Indians. Judging from the number and depth of trails in this vicinity, these springs are much frequented by the Apaches. Around camp there grows an evergreen oak, generally dwarfish, and of but little service other than for fire-wood. At and near the summit of the pass large masses of granite and volcanic rocks are found, outcropping and heaped up into lofty peaks on either side. During the day many Indians visited our camp, some to beg and others to sell mules. They are about to move their camp, the water giving out on the other side of the summit, according well with our experience.

March 3.—Again took up our line of march, the road leading down the dry bed of a cañada, in places narrow and tortuous. Opening out on the plain of the valley of Sauz, there lies in our front, about twenty-four miles distant, a low range of mountains, bare, rugged, and peaked, extending from the Gila southward. On our left a continuation of the ridge from the Dos Cabezas northward, while on our right the view was intercepted by this same ridge extending 11.5 miles eastward. From the mouth of the cañada our trail passes close to the base of this ridge, crossing at right-angles the slopes and valleys making from it.

Reaching the extremity of the ridge, or rather the point of its turning to the south, our road makes directly for a sharp peak crossing the valley, diagonally passing over a uniform slope down to the stream, which we reached just at dark, having made twenty-five miles.

In this vicinity there are neither trees nor bushes to indicate the course of the stream. There is no main bed or channel, the water ramifying through small narrow ditches, or spreading

itself over the surface of the bottom, rendering it marshy and miry. Grass is scarce and salty. The chief growth upon the plain is larrea, agave, and artemisia.

While on the road an Apache family passed us, all mounted. The head of the party informed us there were but two passes through the ridge in front. Towards one we are now bearing, and through the other, which lies to the north, passed the boundary surveying party.

March 4.—Crossed the stream, but not without much trouble. The mules mired badly—so much so that they were unhitched, and the wagons passed over by hand. Followed up the stream a short distance, and again encamped. In order to ascertain the practicability of the passes, two parties were sent out, to each of which I gave a description of the cañon through which Mr. Nugent passed, taken from his notes. Lieutenant Stoneman kindly assisted me, and examined the gap towards which we were travelling yesterday. He found wagon trails leading through it, and the general features of the cañon corresponding with Mr. Nugent's notes, but no spring, as he stated, "under a large cedar tree." Here again were we disappointed. Surely we are crossing this country in its dryest season. Towards evening the parties returned, reporting no trails nor passes between this one and that referred to above.

This morning was intensely cold; quite a skimming of ice even upon the running water. The northern slopes of the peaks of Chiricahui are whitened with snow.

March 5.—Expecting another long stretch without water, the kegs and canteens were filled and mules all watered. A few miles brought us again into our old trail leading up the foot-slope of the ridge, and towards the same gap we were travelling upon two days since. By a gradual and uniform ascent we reached the mouth of the cañon which leads directly through the ridge, and heading close to the plain on the eastern side.

Near the entrance of this gap lies an outcrop of metamorphic, secondary limestone, underlying huge masses of granite, heaped up throughout the cañon in most beautiful confusion. From the stream to this ridge extends a slope displaying a rich growth of grama-grass in patches. From the crest of this ridge had a view quite analogous to that obtained from those already crossed, but somewhat tamer; an immense plain, or rather valley, extending north and south, and bounded by a low ridge on the east, the Gila mountains on the north, and detached mountains on the south, having the appearance of continuity. The ridge on the east gives out towards the north, leaving a continuous plain extending around its northern end. Our course bears, for a depression in the low hills, to the north of a rounded conical peak, and leads us, as before, diagonally across the valley, the bottom being dry, and covered with a dwarfish growth of mezquite, sage, and bunch-grass.

The characteristics of these valleys are their great similarity one with another, and the perfect uniformity in the individual features. The foot-slopes are gentle and smooth up to within a short distance from the ridges, where they assume gradually a greater degree of inclination; and, of a consequence, are rough and indented by drains, the frequency and depths of which depending, in a great measure, upon the altitudes of the parent mountains.

The soil of these slopes is made up of the detritus of the rocks in place in the ridges. Near their bases the surface is strewn with angular fragments, which become ground up and disintegrated the further they are removed from the original rocks, until they are reduced to an impalpable ashen soil, as is generally the case in the bottoms. When near the divide of the low hills, we found on the right of the road, in the bed of a dry gully, a hole made by some of our predecessors, containing about a bucket-full of water. After a little digging, the supply was found to be constant, but at the same time very small. We, however, encamped, having made 21.6 miles. This spring is indicated upon the sketch; but I scarcely think it is permanent, the surrounding features giving it more the appearance of a blind drain of the surface-water collected in the immediate vicinity. Lieutenant Stoneman had it deepened about two or three feet, and then managed, by great care and attention, to give each team-mule a bucket-ful—an operation requiring at least three hours. Some of the men were up at intervals during

the night, each watching his turn to give his riding-animal another sip. We found near camp a greenish rock, with a slightly malachitic coating, closely resembling an ore of copper.

March 6.—Had during the night high winds, accompanied by a slight shower. Soon after leaving camp we had spread before us another plain of similar character to those before encountered. The road was firm, over a surface strewn with fragments of a compact chocolate-colored igneous rock, with small whitish crystals imbedded. On the right was a large mass of much weather-worn metamorphic scoriæ. In the bottom crossed another playa, (lake of the sketch,) the surface of which was apparently as level as a floor, and so dry and hard that the wagons scarcely made an impression. A joking teamster remarked, "Here is your country for a railroad."

While ascending the slope beyond the playa, we struck into a plain wagon road, crossing from the northwest, made by the boundary surveying party. Following this road we turned the point of the ridge, having, however, two or three knolls on our right. We passed over an uneven country, the drains and ravines all making southward, in which direction is apparently a prairie extending from the playa around the terminus of this ridge to the eastward. Our plain road divided up into a number of trails, leading off into various directions; and finally losing all traces of them, we took a course eastward, expecting soon to reach the emigrant road, (Cook's wagon trail.) Having made 27.9 miles, we camped without water, being again unsuccessful in finding an indicated spring. Grass in abundance, but a scarcity of wood. Throughout the day the wind was high and weather squally.

March 7.—Continued on the course of last evening about a mile, and struck Cook's trail at the very point where Nugent departed from it; the surrounding topography according with the sketches; and, in addition, there were visible faint traces of an old wagon trail. This road is here broad and well beaten, being through this region the only route travelled by the southern emigration to California. From this point there extends eastward a prairie, unobstructed by a continuous ridge, over which I should, in accordance with my instructions, take a direct course to the Rio Bravo. But, as this would involve the necessity of another ninety miles' march without water, and there being no doubt about the practicability of a railroad over it, I have determined to follow for the present the emigrant road into Mesilla, deeming the other an undertaking too hazardous with our animals in their present condition, completely fagged and leg-weary, the results of a succession of long stretches without water which we have encountered since leaving the Pimas, and over which we were obliged to travel with rapidity by night as well as day.

Following the road a short distance, we struck the arroyo or valley coming down from the Ojo de Inez; but, not finding here any water, we pushed on to the Ojo de Vaca, passing over a gently undulating prairie, the slopes and drains of which run southward. Camped, having made 12.6 miles, with fine grass, slightly brackish water, and no wood—the roots of the dwarf mezquite serving all the purposes of cooking. This spring is situated in a slight depression in the prairie, with rounded knobs or knolls on the north, and an insulated rock-capped excrescence on the south. The water, flowing but a few yards, forms quite a marsh, surrounded by rushes and cane; the drain or valley making from it, like those we have encountered since leaving the point of ridge east of the playa, (lake,) spreading out into the broad prairie.

March 8.—Sent this morning two men to Fort Webster, near the copper mines, and about fifteen miles north of the crossing of the Mimbres, to report our arrival in this vicinity, and invite the officers of the garrison to visit us at our camp on the Mimbres, where we expect to remain during to-morrow. From these gentlemen I expect to gain much additional information respecting the section of country lying south of the boundary line, parallel 32° 22′ and extending to the Rio Bravo.

Allowed our mules to graze until 10, when we started for the Rio Mimbres, having a most excellent road over a swelling grassy prairie, crossing at right-angles, as a general thing, the line of greatest declivity. Approaching the Rio Mimbres from the west, one unac-

quainted with its locality is completely deceived, finding himself, when apparently ascending the slope from the Picacho de los Mimbres, very unexpectedly on the summit of a low divide, at the bottom of which lies a meandering line of cotton-woods and willows, indicating the river's course. Although these trees are now destitute of foliage and have a very wintry aspect, the trunks and bare branches nevertheless afford a very pleasing relief. Camped a short distance above the crossing, the grass having been burned in that vicinity. The stream is now about six feet wide, and one foot deep. The water is clear and cold, and flows over a pebbly bottom, with a rapid current; and, like most of the streams throughout this country, although dignified by the title of rio, (river,) its waters disappear soon after leaving the mountains, sinking into the sands a short distance below the road.

Shortly after Lieutenant Stoneman and I had turned in, the men sent to Fort Webster returned, bringing strange and somewhat startling intelligence. Instead of finding a flourishing post, garrisoned by three companies, as was expected, they found not a soul, and the post in ruins, most of the buildings burned to the ground, and the remaining ones sacked—all a perfect wreck; and from the facts of the embers still smoking, and the great number and freshness of the Indian tracks, the depredation has been committed within the last few days. Not an Indian was to be seen, although frequent fires were seen while coming down the river. We must be more cautious and circumspect in our movements hereafter. To be in such close proximity to Indians and not see any of them, indicates clearly that all is not right. Soon after the establishment of this post, these Indians located themselves in its immediate vicinity and commenced cultivating. This whole affair is wrapped in uncertainty, which will not be cleared up until we arrive at Fort Fillmore.

March 9.—Remained in camp to-day, being a fine opportunity for our animals to graze and rest, both of which they stand much in need of, having performed trying and severe duties.

March 10.—Passed a cold night, the thermometer being at sunrise 20°. The Apaches did not disturb us. Left camp at half-past 6 o'clock, and, crossing the stream, we followed the road, which is equal to a turnpike, on a course tangent to the southern end of the Picacho de los Mimbres. On nearing this mountain, we found that, instead of turning it, the road, after passing over two or three ravines, crosses a low spur by a steep ascent, but gradual descent, to Cook's spring, at its base, where we camped, having made nineteen miles. This spring is a hole, or rather a pond, of sulphureous water, which disappears a short distance from its source. There are no trees, not even bushes, to indicate the existence of this spring. Wood is very scarce, "bois de vache" being called into requisition.

Around the terminus of this ridge extends a plain, the continuation of that which absorbs the waters of the Mimbres. How this plain is connected or disconnected with the Rio Bravo bottom, remains to be seen.

March 11.—Having now before us a long stretch, by report sixty miles to the river, without water, we did not leave camp until noon, thus affording our animals an opportunity to graze and take a long draught prior to entering upon this jornada.

From the spring our road lay across a plain, sloping southward, in which direction the view was unbroken by mountain ridges or peaks. So smooth was it, that we had frequent examples of the delusive mirage. Crossing this plain, we ascended a divide, from the crest of which we had spread before us another plain of similar character, but sloping, singularly enough, to the north. Beyond this is a system of mesas, encrusted with a black, volcanic rock, the surface of which is nearly horizontal. In many places this whole crust has been removed, leaving rounded and gently swelling hills. By easy descent we reached the divide beyond, and camped at eight in the evening, having fine grass, but no water nor wood. Distance twenty-three miles.

From Cook's spring there appears to be a break in the ridge of hills to the east, south of the wagon road, and directly opposite the opening between the southern end of the spurs from Picacho de los Mimbres and the Sierra Florida. Should this plain extend to the river, a great advantage will be gained over the route at present travelled.

March 12.—Got off by early dawn, and encountered the same description of country as that of yesterday. Broad, smooth valleys, separated by low ridges, the ascents and descents of which were easy and gentle, except where we came in contact with the volcanic covering of the mesas. As we neared the river our road became rough, encountering, while descending from the mesas, gullies and drains with steep slopes, and a long, dry, sandy ravine, leading down to the bottom of the Rio Bravo del Norte. We camped at sundown on the bank of the river, at the mouth of this ravine, and near the parallel of 32° 22′, the boundary between the United States and Mexico, as settled by the commissioners empowered by the treaty of Guadalupe Hidalgo.

We are now in the well-known Mesilla valley, a small portion of the Rio Bravo bottom lying between the river and the low table-land (Mesilla) on the west; Doña Ana is in sight on the opposite side of the river. Made twenty-seven miles, the entire distance from Cook's spring being fifty miles.

March 13.—Followed down the river, and soon got into the fields, the wagon road passing directly through them, there being no other obstacles than the numerous and ramifying acequias, (irrigating ditches,) many of which had been bridged.

The town of Mesilla is, although new, a very thriving and busy place, and has a rapidly-increasing population. Passing through the town, we crossed the river and encamped in a grove of cotton-woods in view of Fort Fillmore. Although the route just passed over from Cook's spring to the river is practicable for the construction of a railroad, and at the same time being satisfied that the gaps or breaks bearing southeast from the spring present another equally so; still, wishing to compare the two, I determined to retrace our steps in order to make a profile of the latter. Accordingly, on the 17th of March I started with an escort, commanded by Lieut. R. Ransom, 1st dragoons; having obtained from the post fresh animals, both riding and pack, for which, and other assistance, I am much indebted to Major E. Backus, commanding, and to Lieut. J. C. McFerran, acting assistant quartermaster.

Retracing our steps, we camped at the last water, the point where the road leaves the river.

March 18.—Showery during the night. Packed up, and soon after leaving camp the showers of last night turned into a settled rain, rendering the travelling anything but comfortable. We, however, pushed on till half-past 3, when luckily finding two or three cedar bushes in a ravine on the right of the road, (wood being an exceedingly scarce commodity,) we deemed it advisable to make camp. Succeeding in making a fire, we huddled around it, alternately steaming our knees and backs until 9 o'clock, when we turned in with a fair prospect of getting, if possible, more thoroughly soaked, there being no cessation in the rain; and we started without a single tent, the only shelter or protection being one India-rubber poncho.

March 19.—All hands contributed towards the making up of a very sorry picture; even the horses and mules looked most forlorn.

It remained cloudy and threatening during the morning, but at noon the sun made his appearance—a very welcome visitor. We halted to dry our blankets and packs. At sundown we reached the spring.

March 20.—Started southward, skirting the bases of the spurs making from the Picacho de los Mimbres. Continued on this course seven and a half miles, reaching a point in the gap between the Picacho and the Sierra Florida, from which I could see westward, over an almost perfectly level plain, the conical hills to the south of the Ojo de Vaca, while towards the east lay a continuation of the same character of country. Started eastward, bearing towards the middle of a gap between the mesas, over which the wagon road passes, and the low hills to the south. Took several barometric readings; camped at sundown, encountering thus far no obstacle whatever to the construction of a very easy grade. In fact, it was difficult in many places to detect a slope; and if any, the direction. Camped in the open prairie with fine grass, but without wood and water; distance 18.5 miles.

March 21.—Wishing to reach the river before night, we started at 2 a. m., and after con-

tinuous travelling reached the river-bottom at noon. After halting a couple of hours, we moved on to our camp at the post; distance thirty-five miles.

The map has been constructed simply from bearings taken by a prismatic compass, and distances along the route measured by a viameter. Before entering upon the field of the survey, my chronometer most unfortunately met with an accident, rendering it unserviceable. For the latitude and longitude of the point of departure on the Gila, of Tuczon, and of the point of striking the Rio Grande, I am indebted to Major W. H. Emory, topographical engineers, in charge of Mexican boundary survey.

The red full line is the line of survey over which the wagons passed. The red dotted is the line of survey made by returning from camp on Rio Bravo, having a small party with pack-mules. The full blue line indicates where, and how, obstacles encountered upon the full red may be avoided, as shown in the profile and notes; and although it does not indicate a line actually passed over and surveyed, it nevertheless is located from observations made while on the field. The blue dotted is suggestive, and indicates where still further improvements may *probably* be made, depending upon other explorations and detailed surveys. By referring to the map it will be seen that the dry bed of stream passing Tuczon has, after leaving the point of the hill at camp No. 12, station 2, a slope and direction towards the northwest, which, according to information obtained at Tuczon, it retains until reaching the Rio Gila, opening out into its bottom at a point about twenty-five miles below camp No. 10. In that case a saving of distance will be had, and a continuous grade obtained from the Gila to Tuczon.

In the Puerto del Dado it may be found practicable and advantageous, after a minute survey, to pursue the blue dotted line, crossing the ridge of a low spar, and thus obtain a less curved trace; and in case the cutting and embankments upon either of the lines in the Puerto require too much work, the whole ridge may be turned on the north, the maximum elevation to be overcome being not more than 4,862 feet, the approximate altitude of camp Castro, in the foot-hills of Mount Graham, furnished me by Major W. H. Emory, topographical engineers; but this detour will be made greatly at the expense of distances. From the plain of the Playa de los Pimas a gap was seen extending towards the mouth of the San Pedro, apparently a continuation of the plain.

Should a practicable descent be found in this direction to the San Pedro, and thence to the Rio Gila, this route will possess decided advantages when taking into consideration the questions of water and distance.

After turning the Chiricahui mountains, a more direct route eastward may be had, depending upon the practicability of the gaps in the ridge to the east of the Valle de Sauz.

From camp No. 24, station 4, an open plain extends in the direction of blue dotted line, presenting, as far as could be observed, no other obstacle than the lack of water, to the running of an almost direct route tangent to the northern end of Sierra de Florida.

When reaching the Rio Bravo I found that to pursue the survey through northern Texas, as was suggested in my instructions, would involve the necessity of incurring a debt equal to the amount of appropriation allowed me; and as Captain Pope, of topographical engineers, had started about one month previous on this line, I deemed it advisable to close my work, discharge such of my party as could be dispensed with, and start to this city by the most direct and expeditious route via San Antonio and Indianola, Texas.

PROFILE.

No. 1, the lower, is the profile of line passed over by the wagons during the survey, indicated upon the map by a full red line, and is constructed from altitudes measured by Green's cistern barometer 387 and 392, and distances measured by a viameter attached to a wheel of the instrument wagon, by assuming the altitude of the starting point on the Rio Gila as zero, and referring the altitudes of the several points along the line to it. It therefore gives approximately

the relative elevations of not only the camps, the main summits or divides encountered and valleys crossed, but also the various intermediate accidents or changes in the surface passed over, the barometer being put up and reading taken at every apparent deviation from the uniform slope.

No. 2, the upper, is constructed with reference to the sea-level, and shows the average grades with which the several sections of the route may be passed. The dotted lines being those attainable by deviating from the red line at points indicated, and following the blue, thereby the grades are improved and the line shortened; but at the same time the question of water is thrown out of consideration.

Commencing at the Rio Gila, we have from camp No. 10 a smooth, plain country extending as far as camp No. 15, station 1, presenting a stretch of ninety-seven miles of easy grades, requiring but little work, the maximum grade being fifty feet per mile from camp No. 14, station 1, to camp No. 15, station 1, a distance of nineteen miles.

At camp No. 15, station 1, we entered a cañon leading from the Cienega de los Pimas, in the gap, by descending abruptly from the plain on its left bank to its dry sandy bottom. By a side-cutting this cañon can be entered with a grade of nineteen feet. Reaching camp No. 16, the summit of the divide between the Cienega and the Rio San Pedro can be attained without trouble; but it is impracticable to continue on this line (the red) to the river. This difficulty can be overcome by deviating at camp No. 16, station 3, and following blue line through camp No. 17, station 1, and camp No. 17, station 3, and skirting along the bases of the hills bounding the valley to a point near camp No. 19, station 1, where, crossing the river, the ascent of the dry ravine leading from the range beyond is commenced. Through the cañon above camp No. 16, there will be required rock-cutting at points where, it becoming narrow and tortuous, rocky projections are presented as obstacles to either a right-line or gently curving trace. The walls of this cañon being, however, in no instance over eighty feet, and seldom over fifty feet high, and at many points, where it widens out to a valley, they are replaced by low, rounded hills, no insurmountable obstacle to an average grade of thirty-eight feet per mile is encountered as far as the summit, camp No. 17, station 1. From this point, by pursuing the line indicated, the bottom of the San Pedro may be reached by a grade not exceeding sixty-one feet per mile, and will require but light cutting, the slopes of the foot-hills being of a loose clay. The river can be bridged by a single short span, the water-way being about twenty-five feet wide.

Between the San Pedro and the Playa de los Pimas a low ridge intervenes, the approach to which is by a dry arroyo or drain leading from a gap in its crest, bounded by rounded hills and occasional walls, varying from twenty to fifty feet in height, made up of a semi-hardened conglomerate mass of débris of granitic and volcanic rocks. In the gap there lies a rolling prairie-like country, extending in an unbroken plain down to the playa. This divide can be crossed with an average ascending grade of sixty-two feet, and a descending one not exceeding fifty-four feet.

From the Playa de los Pimas the line crosses the Chiricahui range, passing through the Puerto del Dado. By the line travelled, the ascent to the summit of this pass lay over a smooth plain until reaching the foot-slopes of the mountains, when it became undulating, crossing valleys and their divides; whereas by curving to the southward these foot-slopes will be avoided, and a continuously ascending slope is found, giving, after making a sixty-feet cutting at the summit, a grade less than forty-six feet per mile, that obtained by following the direct red and blue lines. Leaving the summit and following the red line, we find that in the distance 4.7 miles to camp No. 22, station 1, a descent of seven hundred feet is made; and that thence to camp No. 22, station 4, distant seven miles, there is an additional descent of one hundred and eighty-one feet. The line in this descent crosses lateral ravines making from the summits on the right until reaching a point a few yards below camp No. 22, where it enters the main drain, and follows down its bed to the opening on the plain at camp No. 22, station 1. It thence passes to station 4, along the base of the ridge projecting eastward from the Puerto.

Starting from the summit with the above cutting, and hugging the ridge with a curving trace, as indicated by the blue line, station 4, or the level of that station, can be reached by a grade not exceeding seventy feet per mile. This will require, in addition to the rock-cutting at the summit, heavy side-cutting and embankment. At and near the summit large masses of granite are out-cropping, while below camp No. 22 the walls of the cañon are made up of a much tilted and contorted stratification of a slaty sandstone and limestone.

From this station 4, our route lay over a smooth plain, descending apparently uniformly to the stream at the bottom of the Valle de Sauz. Upon this plain a continuous grade of about thirty feet per mile can be constructed with but little labor, the ground being already, as it were, graded. The stream is no obstacle. But from it, at camp No. 23, to the summit of the gap in the ridge beyond, there is an ascent of seven hundred and seventy-one feet, requiring, after making a sixty-feet cutting at the summit, a continuous grade of about ninety feet to overcome it, following either of the lines indicated; but as the approach to the entrance of this gap is over an unbroken slope, this grade can be reduced by ascending the slope diagonally, thus increasing the distance.

The gap is wide and open, with the exception of about a hundred yards at the summit, where it narrows down to a cañon, with granite wall.

No difficulty is found in crossing the valley, which is made up of smooth slopes lying between camp No. 24, station 4, and camp No. 25, station 1. The maximum grade is but sixty-eight feet per mile, the natural slope ascending to camp No. 25, station 1.

Beyond this point lies another bottom, bounded by a low spur, giving out and sinking into the plain towards the south.

For considerations of water we continued eastward, hugging and skirting the extremities of the spurs of this ridge until reaching Cook's trail, which we followed to the Ojo de Vaca, and then pursued the trail to the Rio Bravo. By observations made on the ground, it was found perfectly practicable to construct a line of grades answering the purposes of a railway communication along or near the route travelled, the maximum grades being encountered in ascending the summit of camp No. 25, station 7, and at the Rio Mimbres; in the first case, 78.7 feet, and in the second 89 feet, allowing sixty feet for cutting and the same for embankment, and even these grades can be greatly reduced by a slight deviation to the south at these points. But, since the several spurs, valleys, and slopes crossed make southward and amalgamate, forming a continuous plain unobstructed by rough ridges, the line or route to the river can be improved, not only in its grades, but also be shortened by diverging at camp No. 25, station 3, and pursuing a general direction, as indicated by the blue line, to its junction with the red dotted, and thence following it to the river; the profile of this latter having been determined barometrically.

Profile No. 2 gives, in the dotted line, the average grade attainable by following the course above indicated, the maximum being about fifty feet, that required in making the ascent from the point of divergence to "A" on the horizontal curve, passing through camp No. 25, station 6, and thence ascending to B, the approximate altitude of which is five thousand one hundred and seventy-seven feet, after assuming that the fall of the ravine from camp No. 26, station 2, to the point "B," is at least ten feet per mile. But little work will be required throughout this stretch, deep cutting being avoided by gently curving the trace.

From Cook's spring, camp No. 29, to the river, the profile of wagon route shows no great altitudes to be overcome, the chief obstacles being the abrupt ascent at camp No. 29, stations 3 and 4, crossing the ridge at camp No. 30, stations 1, 2, and 3, and descending to the river-bottom from camp No. 30, station 8. At these points heavy grades are necessary, but the difficulties can be entirely avoided by pursuing, instead of the red full line, the red dotted line; the profile of which is given in No. 2, connecting with the dotted or profile of blue line from C. This indicates a smooth, prairie-like surface, according well with the observations made on the ground, that it was difficult to tell, in many places, the direction of slope. This smooth sur-

face, or mesa, has an average altitude above the river-bottom of three to six hundred feet, and is connected with it by an irregular step of a loose, light soil, extending to a point opposite, and a short distance below Fort Fillmore, where, in place of the deep-washed, loamy slope, is found an outcrop of a black, igneous rock, with a foot-slope of its angular debris. To descend to the river-bottom will require a diagonal trace, hugging the mesa slope, until a distance is made sufficient to overcome the difference in altitude; the direction of this depending upon location of route to the eastward, whether leaving the valley at the pass near Doña Ana, or on the south at El Paso.

The supply of timber along the route is very limited. Cotton-wood, the only growth of size sufficient to answer the purposes of sills, is found in but four localities; on the Gila, at Tuczon, on the Mimbres, and Rio Bravo. Water being so essential to the very existence of this tree, it only grows on the banks of streams, and disappears with the sinking of the waters, as is the case at Tuczon and Rio Mimbres. At Tuczon I was informed that a variety of the pine is found in the cañadas of Sierra de Santa Catarina to the east and northeast of the town. In the mountains, about fifteen or twenty miles north of the crossing of the Mimbres, the pine also exists. But the plains are entirely destitute of trees of any description, and the mountains have a general appearance of sterility and ruggedness, yielding in the concealed nooks and valleys a meagre growth of cedar and dwarfish evergreen oak.

The rocks are generally of a metamorphic character, but there is found at many points along the line stone answering well the purposes of construction. Granite appears in the Cienega de los Pimas, in the ridge to the east of the San Pedro, outcropping in the Puerto del Dado, and overlying masses of secondary limestone in the ridge east of the Valle de Sauz. Sandstone and limestone are both found in the Puerto del Dado. Near the Rio Bravo both limestone and gypsum are found, the veins or seams of the anhydrous variety of the latter being exposed in the clayey walls of the ravine leading down to the river.

There is a great scarcity of water along the line, there being but nine localities where the supply could be said to be permanent. These are: 1st, at Tuczon—a clear running stream, but disappearing a few hundred yards below the town; 2d, in the Cienega de los Pimas—fine springs, but the water soon sinks into the sand, as is the case at camp No. 16; 3d, the Rio San Pedro, a turbid stream, winding its way to the Gila; 4th, a spring near camp No. 22, in the Puerto del Dado—the water cold and very palatable, but the supply very limited, our animals having entirely exhausted the basin before they had a sufficiency; 5th, in the bottom of the Valle de Sauz—a stream of clear but slightly brackish water, spreading out into a marsh and extending towards the Gila in a succession of pools; 6th, a hole near camp No. 25, where, although the water rose in the bottom, still every other feature would indicate that a blind drain of mere surface-water had been tapped; 7th, the Ojo de Vaca—a spring of slightly sulphureous water, rising in the open plain and forming a marsh, beyond the limits of which there is no appearance or indication of the existence of water; 8th, Rio Mimbres—a rippling mountain stream of clear cold water at the crossing, being the more beautiful from the contrast with the state of things a few miles below, where the water is absorbed by the parched plain, the trees disappear, and there is nothing left but the dry, gaping bed; 9th, Cook's spring—is of similar character to the Ojo de Vaca, and bears more of a resemblance to a pond-hole than to a spring.

In addition to the above constant waters, there are holes or depressions on the plains intervening, which are filled by the rains of the wet season, and thus often afford relief to the anxious and solicitous traveller. These holes are lined with a clay allowing but little absorption; but, being generally shallow and broad-surfaced, evaporization soon empties them of that necessary which one requires, but has to be deprived of in order fully to appreciate it.

At Tuczon the rainy season commences in April, and continues for three or four months; so that the emigrant who passes this point during the summer months finds himself in this country in the most favorable season with water abundant and grass green and nourishing, whereas we were there, and *en route*, about the end of the dry season, as our experience proved, meeting

a different state of things; so that one's views and opinions of this country depend entirely upon the season during which he visits it.

Whether water can be obtained on these plains by digging within reasonable limits, is a question purely problematical, to be solved in every case by experiment, owing to the geological structure of the country. This experiment I consider worthy of attention, not only on account of its great and all-important bearing upon the question of locating a line for railroad over this country, where are intervals of fifty and seventy miles between permanent waters, but also, if successful, on account of the relief rendered the various parties crossing during the dry season, whose sole and great anxiety now is, when entering upon these jornadas, to get their animals through to the next water.

Before closing this report, I take great pleasure in expressing my thanks for the many kind offices and valuable assistance rendered throughout the trip by Lieutenant George Stoneman, 1st dragoons, and commanding escort, an officer full of expedients and experience, the results of eight years' campaigning; also to Dr. A. L. Heermann, physician and naturalist, and to Mr. Henry Custer, assistant; both of whom displayed a proficiency in their professions only equalled by the zeal bestowed upon the discharge of their respective duties.

I have the honor to be, very respectfully, your obedient servant,

JNO. G. PARKE,
Lieutenant Corps Topographical Engineers.

Hon. JEFFERSON DAVIS,
Secretary of War.

TABLE OF BAROMETRICAL MEASUREMENTS, WITH THE REDUCED APPROXIMATE ALTITUDES.

First column of heights.—Those entered in this column were obtained by referring the principal camps to each other, and the intermediate stations to the nearest well-determined camp. The barometric reading was first reduced to 32°. After which, a correction was applied, on account of hourly variation, taken from the following table, prepared by L. Blodget, Esq., of the Smithsonian Institution, after a careful and close investigation of hourly observations made during the survey of the Mexican boundary; and that of Lieutenant Whipple, topographical engineers, in corresponding longitudes and neighboring latitudes.

6 a. m	—.010
7 a. m	—.040
8 a. m	—.045
9 a. m	—.050
10 a. m	—.057
11 a. m	—.070
12 m	—.032
1 p. m	+.009
2 p. m	+.030
3 p. m	+.040
4 p. m	+.050
5 p. m	+.045
6 p. m	+.035
7 p. m	+.025
8 p. m	+.010
9 p. m	+.005

Second column of heights—Contains the elevations obtained by referring each observation to the sea-level; barometer assumed to be 30.050; thermometer, 64°. The barometer was corrected for temperature and horary variation, as in column 1st.

These reductions were made by D. G. Major, Esq., under the direction of Mr. Blodget, who furnished the tables and formulæ, and, at my request, the following communication referring to their application:

"SMITHSONIAN INSTITUTION, *July* 16, 1854.

"DEAR SIR: At your request, I make the following note of the direction given to the reduction of the barometric observations made on your line of survey from the Pimas villages, on the Gila river, to El Paso. They were reduced in part by the aid of new constants and new modes of correction, which require some explanation.

"Determinations of elevation by the barometer are subject to error from two causes not considered in the formulæ and tables usually employed, or those providing for this determination, though simultaneous observation on a vertical line.

"The survey of an extended surface-line necessarily involves liability to those errors, and it cannot be accurately made by the principles applicable to vertical and simultaneous comparisons alone.

"The sources of error are, first, variable constants of atmospheric pressure, both in the changes for the day and among the months; and, second, non-periodic changes, or variations without regularity or definite recurrence.

"To avoid the first error, or that arising from horary variations of pressure, a scale of correction for the observations made at each hour has been applied, reducing each reading to a mean position for the day. This scale is a new one, of larger range of variation than that applicable in the eastern United States and in Europe; and it was determined from hourly observations made by the survey under Lieutenant Whipple, corrected and confirmed by reference to the results of hourly observations by the boundary survey, which were made accessible for this purpose by Major Emory and Mr. Chandler. The scale is given in connexion with the computation and results.

"To correct the work for non-periodic variations of pressure, the principal camps are referred to each other consecutively, and each to a principal camp; correcting the determination by the mean of these results. Each camp is also referred directly to the sea-level, assuming a mean pressure at sea-level in those latitudes of 30.050 inches, with the barometer corrected to the reading at freezing-point, and the air temperature at 64°. These results agree very nearly with those obtained by the first and preferable mode.

"The intermediate stations and minor camps are first referred to the nearest principal camp; and the line formed by successive differences from such point of departure is corrected, if found not to agree with the single difference determined from camp to camp by a proportional correction of the intermediate elevations. The result of elevations are still liable to error, from a measure of non-periodic variation that cannot be determined, but they are the best possible in this description of survey, without simultaneous observations at stations very near each other.

"The correction for monthly variation of pressure would be very small at the date of this survey.

"It is proper to say that the greatest error probable in the determination of the absolute elevation of any camp by those methods cannot exceed one hundred feet, and the error of any grade would be wholly unimportant.

"Respectfully, yours,

"L. BLODGET.

"Lieutenant PARKE,

"*In charge of Survey of Line from Gila river to El Paso.*"

Barometrical Observations and approximate Altitudes of camps and stations along the line from the Pimas villages, on the Rio Gila, to Mesilla, on the Rio Bravo.

Station.	Date.	Hour.	Number of barometer.	Height of column.	Attached thermometer.	Detached thermometer.	App. altitude, No. 1.	App. altitude, No. 2.	Distance from the preceding station.	Distance from camp to camp.	Remarks.
Camp 10, on the Gila.	Feb. 15	Sunset	387	28.770	47.5	.....	.....	.....	.....	.....	Clear.
		Sunset	392	28.780	48	50	.....	.....	.....	.....	Do.
	Feb. 16	Sunrise.....	387	28.637	25	.....	.....	.....	.....	.....	Do.
		Sunrise.....	392	28.613	28	25	.....	.....	.....	.....	Do.
		8.....	387	28.702	62	.....	.....	.....	.....	.....	Do.
		8.....	392	28.710	61	47	.....	.....	.....	.....	Do.
		9.....	387	28.730	69	.....	.....	.....	.....	.....	Do.
		9.....	392	28.732	72	56	.....	.....	.....	.....	Do.
		10.....	387	28.738	72.2	.....	.....	.....	.....	.....	Do.
		10.....	392	28.734	75.5	61	.....	.....	.....	.....	Do.
		11.....	387	28.732	79.5	.....	.....	.....	.....	.....	Do.
		11.....	392	28.730	82	62.5	.....	1364.7	.....	.....	Do.
1.....	Feb. 16	2.....	387	28.600	77	76	1457.9	1503.2	2.7	.....	Do.
2.....	Feb. 16	Sunset	387	28.475	68	70	1650.7	1682.2	8	.....	Do.
Camp 11.....	Feb. 17	Sunrise.....	387	28.340	38	.....	.....	.....	.....	.....	Do.
		Sunrise.....	392	28.350	38	40	1668.4	1660.7	12.40	23.10	Cloudy from zenith to horizon in the west; southerly breeze.
1.....	Feb. 17	9.30.....	387	28.375	58	56	1712.2	1722	7		
2.....	Feb. 17	11.30.....	387	28.278	70	65	1835.1	1861.3	5.50		
3.....	Feb. 17	2.30.....	387	28.176	80	73					
		2.30.....	392	28.196	84	73					
		3.....	387	28.152	72	69	.....	.....	.....	.....	Cloudy; strong west wind.
		3.....	392	28.160	73	69					
		3.30.....	387	28.140	70	66					
		3.30.....	392	28.150	71	66					
		4.....	387	28.138	67	65					
		4.....	392	28.145	68	65	1869.3	1891.5	2.30		
4.....	Feb. 17	Sunset	392	28.120	64	63	1886.4	1908.4	1.40	.....	Strong south wind; clear in the west; showery for half an hour from 4 a. m.
Camp 12.....	.....	.....	.....	.....	.....	.....	.....	.....	10.9	27.10	
1	Feb. 18	Sunrise.....	392	28.070	47	46	1971.8	1963.1	2.66	.....	Heavy clouds; wind south.
2.....	Feb. 18	7.30.....	392	28.025	47	45	2010.2	1998	2.5	.....	Heavy clouds to the east; clearing in the west.
3.....	Feb. 18	8.50.....	392	28.032	55	52	2064	2037.7	5.45	.....	Sun breaking through the clouds.
4.....	Feb. 18	11.30.....	392	27.950	65	60	2161.5	2169.1	5.82	.....	Cloudy.
Camp 13.....	Feb. 18	Sunset	.....	27.900	44	44	2078.4	2090	3.06	19.50	Showery; heavy clouds in the east; wind west.
	Feb. 19	Sunrise	392	27.984	38	39	.....	.....	.....	.....	Clear in eastern horizon; from zenith to the west overcast; thin clouds.
		Sunrise	387	27.980	38	39					
		8.....	392	28.040	62	50	.....	.....	.....	.....	*Fleecy clouds.*
		8.....	387	28.030	61	50					
		9.....	392	28.050	61	55					
		9.....	387	28.035	59	55					
		10.....	392	28.045	62.5	65	.....	.....	.....	.....	*Clouds disappearing.*
		10.....	387	28.055	73.5	65					
		10.....	.....	28.05							
		11.....	392	28.032	62.5	58	.....	.....	.....	.....	Cum. clouds; north breeze
		11.....	387	28.030	60.5						
		12.....	392	27.97	69	68	.....	.....	.....	.....	Cum. clouds.
		12.....	387	27.99	75	68					
		1.....	392	27.955	66	60	.....	.....	.....	.....	Cum. clouds; northerly breeze.
		1.....	387	27.960	65	60					
		2.....	392	27.940	76.5	68	.....	.....	.....	.....	Cum. clouds; northwest breeze.
		2.....	387	27.960	74	68					
		4.....	392	27.915	70	60	.....	.....	.....	.....	Clouds.
		4.....	387	27.918	68	60					
		5.....	392	27.905	66	59	.....	.....	.....	.....	A few clouds in easterly horizon; north wind.
		5.....	387	27.900	64	59					
		Sunset	392	27.860	49	52					
		6.....	387	27.855	49	52	.....	.....	.....	.....	Perfectly clear and calm.
	Feb. 20	Sunrise	392	27.825	37	38	2078.4	2090	3.06	19.50	Clear and calm.
Camp 14.....	Feb. 20	12.....	392	27.780	67	60	.....	.....	9.60	9.60	Clear and southwesterly breeze.
		12.....	387	27.770	67.5	60					
		1.....	392	27.773	74	63	.....	.....	.....	.....	Do.
		1.....	387	27.753	67	63					
		2.....	392	27.760	75	64	.....	.....	.....	.....	Do.
		2.....	387	27.740	73	64					
		3.....	392	27.750	64.5	60	.....	.....	.....	.....	Do.
		3.....	387	27.740	70	60					
		4.....	392	27.760	73.5	56	.....	.....	.....	.....	Do.
		4.....	387	27.740	67	56					
		5.....	392	27.750	59	54	.....	.....	.....	.....	Do.
		5.....	387	27.730	64.5	54					
		Sunset	392	27.730	51	52	.....	.....	.....	.....	Do.
		Sunset	387	27.720	51	52	.....	.....	.....	.....	Do.
	Feb. 21	Sunrise	392	27.730	31	32	.....	.....	.....	.....	Clear, calm, and cold.
		Sunrise	387	27.720	30	32	.....	.....	.....	.....	Do.
		8.....	392	27.772	48	36	.....	.....	.....	.....	Do.
		8.....	387	27.772	46	36	.....	.....	.....	.....	Do.

Barometrical Observations and approximate Altitudes, &c.—Continued.

Station.	Date.	Hour.	Number of barometer.	Height of column.	Attached thermometer.	Detached thermometer.	App. altitude, No. 1.	App. altitude, No. 2.	Distance from the preceding station.	Distance from camp to camp.	Remarks.
Camp 14	Feb. 21	11	392	27.800	75	69					Light easterly breeze.
		11	387	27.800	76	69					
		1	392	27.732	73	72					Light northerly breeze.
		1	387	27.740	80	72					
		4	392	27.745	74	68					
		4	387	27.734	71	68					
		Sunset	392	27.730	59	60					
		Sunset	387	27.724	59	60	2282.8	2300.7	9.60	9.60	Strong westerly breeze; few clouds on horizon.
1	Feb. 22	2	392	27.725	90	84	2349.8	2432.1	4.35		Clear and calm.
Camp 15	Feb. 22								4.10	8.45	
1	Feb. 23	2	392	26.820	81	75	3273.2	3333.6	15.10		Thin clouds in the east; fresh breeze.
2	Feb. 23	3	392	26.925	86	78	3146.1	3229.3	0.34		
Camp 16	Feb. 23	5	392	26.800	79	72					Strong west wind; thin clouds.
		Sunset	392	26.785	66	64					
	Feb. 24	Sunrise	392	26.615	34	32					West wind; thin clouds to the northwest.
		8.30	392	26.660	46	46					West wind; clouds.
		9.30	392	26.680	52	47	3335.6	3348.8	2.62	18.06	West wind; strong indication for rain.
1	Feb. 24	10.30	392	26.660	58	52	3442.8	3456.7	0.85		West wind; clouds cum.
2	Feb. 24	2	392	26.565	55	52	3650	3661.7	7.70		Strong west wind.
3	Feb. 24	3.30	392	26.282	65	56	3751.6	3778.6	1.84		Do.
Camp 17	Feb. 24	Sunset	392	25.760	45	46					Do.
	Feb. 25	Sunrise	392	25.825	29	30	4222.7	4197.9	4.93	15.3	Do.
1, off the road	Feb. 25	9	392	26.080	60	51	4027.5	4055			Clear and calm.
2	Feb. 25	10.15	392	26.055	65	55	4070.9	4122.4	5.91		Do.
3	Feb. 25	11.30	392	26.496	69	59	3633.1	3670	2.39		Do.
Camp 18, near San Pedro river.	Feb. 25	3	392	26.660	79	68					Do.
		4	392	26.635	74	64					Clear; west wind.
		5	392	26.605	62	60					West wind; feathery cl'ds in west.
		Sunset	392	26.602	55	52					Do.
	Feb. 26	Sunrise	392	26.495	11	12	3413.3	3419.3	2.74	11.04	South breeze, and clear.
1	Feb. 26	8	392	26.585	42	35					Clear.
		9	392	26.628	61	41			1.97		Do.
		9.15	387	26.600	60	43					Do.
		9.30 a. m	387	26.620	54	45	3492.9	3458	1.97		Clear.
Camp 19	Feb. 27	11.30	387	26.700	75	68	3435.3	3501.6	0.63	2.6	Do.
1	Feb. 27	4.15	387	26.430	86	79	3645.3	3753.4	10.16		Do.
2	Feb. 27	Sunset	387	26.185	63	63	3856.3	3908.5	2.97		Do.
Camp 20	Feb. 28								0.9	14	
1	Feb. 28	Sunrise	387	26.000	29	30	4026.7	3964.6	1.33		Clear and calm.
2	Feb. 28	8.30	387	25.860	66	61	4294.9	4347.4	3.46		Clear; breeze south.
3	Feb. 28	9.45	387	25.720	69	64	4435.9	4531.1	2.40		Clear; strong southwest breeze.
4	Feb. 28	11	387	25.580	71	72	4506.7	4707.9	2.70		Clear; strong southwest breeze.
5	Feb. 28	1.15	387	25.655	76	72	4565.4	4561.4	5.14		Do.
6	Feb. 28	4	387	25.900	78	70	4149.0	4268.4	5.73		Do.
7	Feb. 28	4.45	387	25.910	72	68	4127.9	4236.7	2.19		Do.
Camp 21	Mar. 1								3.24	26.2	Do.
1	Mar. 1	9.15	387	25.310	51	46	4829.3	4842.8	13.53		Strong southwest wind; squally.
2	Mar. 1	12.45	387	25.050	54	49	5066.6	5096.1	7.25		Do.
3	Mar. 1	1.10	387	24.935	58	51	5183.1	5228.6	0.50		Do.
Camp 22	Mar. 1	4.15	387	25.235	54	48			2.33	23.58	Strong southwest wind; clouds in the east.
	Mar. 2	9	387	25.425	48	40					North wind; clear.
		10	387	25.425	54	42					Do.
		11	387	25.410	53	42					Do.
		11	392	25.418	54	42					
		12	387	25.385	50	44					North wind; clear; light clouds in the west.
		12	392	25.395	48	44					
		1	387	25.350	44	46					
		1	392	25.355	44	46					Northwest wind; sky overcast.
		2	387	25.335	64	52					
		2	392	25.340	64	52					Do.
		3	387	25.325	60	52					Northwest wind; clouds in N.W.; clear in zenith.
		3	392	25.322	60	52					
		4	387	25.285	52	52					Northwest wind; clouds in northwest; clear; clouds disappeared.
		4	392	25.280	52	52					
		5	387	25.276	49	48					Wind falling; clouds disappearing.
		5	392	25.275	49	48					
		5.45	387	25.270	44	45					Do.
		5.45	392	25.270	44	45					
	Mar. 3	Sunrise	387	25.260	24	28	4745.6	4751.9	2.33	23.58	Clear and calm.
1	Mar. 3	7.45 a. m	387	25.585	30	30	4482.3	4408.6	2.33		Do.
2	Mar. 3	8.45	387	25.720	62	50	4415.1	4439	0.95		Do.
3	Mar. 3	10	387	25.810	63	53	4328 6	4369	2.35		Clear; light west wind.
4	Mar. 3	11.30	387	25.825	62	52	4300.7	4340	3.77		Do.
5	Mar. 3	3.30	387	26.190	77	67	3844.7	3943	5		Do.

Barometrical Observations and approximate Altitudes, &c.—Continued.

Station.	Date.	Hour.	Number of barometer.	Height of column.	Attached thermometer.	Detached thermometer.	App. altitude, No. 1.	App. altitude, No. 2.	Distance from the preceding station.	Distance from camp to camp.	Remarks.
Camp 23.....	Mar. 4	Sunrise.....	387	26.210	19	20	.....	.....	.....	.....	Clear; northwest breeze.
		7.10.....	387	26.245	33	28	3815	3698.4	8	22.40	Clear; light south breeze.
Camp 24.....	Mar. 4	2 p. m.....	387	26.160	84	75	.....	.....	.....	.....	Do.
		3.....	387	26.162	87	78	.....	.....	.....	.....	Do.
		4.....	387	26.155	87	78	.....	.....	.....	.....	Feathery clouds; light southwest breeze.
		5.20.....	387	26.132	81	75	.....	.....	.....	.....	Do.
		5.55, or sunset.	387	26.100	63	63	.....	.....	.....	.....	Do.
	Mar. 5	Sunrise.....	387	26.045	43	48	.....	.....	.....	.....	Southeast breeze; sky overcast.
		6.50.....	387	26.055	39	39	3967.2	4029.4	2.9	2.9	Do.
1.....	Mar. 5	7.45.....	387	25.945	58	56	.....	.....	.....	.....	South breeze; sky overcast.
		7.50.....	387	25.950	58	56	4180.1	4204.2	1.85	.....	Do.
2.....	Mar. 5	8.50.....	387	25.750	69	63	4434.2	4486.7	1.90	.....	Strong southwest breeze; sky overcast.
3.....	Mar. 5	9.20.....	387	25.588	65	61	4602.2	4646.3	0.70	.....	Strong southwest breeze; clearing.
4.....	Mar. 5	9.30 a. m....	387	25.614	68	65	4586.3	4646.1	0.35	.....	Strong southwest breeze.
5.....	Mar. 5	10.35.....	387	25.748	72	68	.....	.....	.....	.....	Do.
		10.40.....	387	25.748	74	69	4457.9	4542.5	2.10	.....	Do.
6.....	Mar. 5	11.10.....	387	25.865	79	75	4354	4455.9	1	.....	Light southwest breeze; clearing.
7.....	Mar. 5	12.20.....	387	25.900	83	73	4269.5	4359.6	3.20	.....	Hazy and thin clouds in the horizon.
8.....	Mar. 5	1.50.....	387	25.850	88	82	4281.9	4404.9	.....	.....	Light northwest breeze; clear in the horizon.
		2.05.....	387	25.845	82	75	4281.9	4404.9	2.55		
9.....	Mar. 5	4.....	387	25.635	77	72	4582.5	4622	3.50	.....	Southwest breeze; clear in the northern horizon.
10.....	Mar. 5	4.30.....	387	25.500	75	69	4619.8	4697.1	1	.....	Do.
Camp 25.....	Mar. 5	5.20.....	387	25.470	69	70	.....	.....	.....	.....	Strong southwest wind.
		4.45.....	387	25.460	63	63	.....	.....	.....	.....	Clearing.
		6, or sunset..	387	25.455	61	61	4644.6	4701	0.95	19.15	
1.....	Mar. 6	6.40.....	387	25.464	55	55	4697.4	4685.8	0.95	.....	Heavy cum. clouds in southeast; light southwest wind.
2.....	Mar. 6	8.15.....	387	25.685	64	58	4491.4	4517.1	3.25	.....	Heavy cum. clouds in southeast; light south wind.
3.....	Mar. 6	9.24.....	387	25.850	69	63	.....	.....	.....	.....	Fresh south wind.
		9.25.....	387	25.855	71	63	4330.5	4380.5	2.35	.....	Do.
4.....	Mar. 6	10.20.....	387	25.820	70	65	4374.4	4434.6	2.05	.....	Do.
5.....	Mar. 6	11.30.....	387	25.618	70	65	4705.2	4644.6	1.80	.....	Fresh south wind; cloudy and a few drops of rain.
6.....	Mar. 6	1.10.....	387	25.256	75	70	.....	.....	.....	.....	Fresh south wind.
		1.25.....	387	25.258	75	71	4928.3	5011.9	3.50	.....	High southwesterly wind.
7.....	Mar. 6	3.10.....	387	24.790	68	68	5407.5	5476.1	3.25	.....	Do.
Camp 26.....	.....	.....	.....	.....	.....	.....	.....	.....	6.55	23.70	Do.
1.....	Mar. 7	7.....	387	24.910	46	39					
Cook's trail.....	Mar. 7	7.15.....	387	24.915	46	39	5245.6	5215.9	1.54	.....	Clear and calm.
2.....	Mar. 7	7.45.....	387	24.955	50	46	5220.6	5220.7	1.39	.....	Do.
3.....	Mar. 7	9.05.....	387	24.850	59	52	.....	.....	.....	.....	Thin clouds; fresh west breeze.
		9.10.....	387	24.855	57	51	5361	5394.4	1.20	.....	Do.
4.....	Mar. 7	10.40.....	387	25.050	61	56	.....	.....	.....	.....	Scattering cum.
		11.....	387	25.055	60	55	5150.4	5212.8	4	.....	Do.
Camp 27, Ojo de Vaca.	Mar. 7	5.....	387	24.890	64	60	.....	.....	3.10	11.20	Southwest wind; scattering cum. in west.
		Sunset	387	24.878	52	52	.....	.....	.....	.....	Light southwest wind.
	Mar. 8	Sunrise.....	387	24.838	35	35	.....	.....	.....	.....	Heavy clouds in east horizon.
		7.....	387	24.855	45	42	.....	.....	.....	.....	Light west breeze.
		8.30.....	387	24.905	60	51	.....	.....	.....	.....	Do.
		9.....	387	24.908	61	52	.....	.....	.....	.....	Do.
		9.30.....	387	24.902	60	53	.....	.....	.....	.....	Breeze freshening.
		10.....	387	24.900	63	54	5288.3	5312.3	3.10	11.20	Clear in zenith.
1.....	Mar. 8	10.40.....	387	24.865	66	55	5408.2	5335.8	0.60	.....	Clear in zenith; west breeze.
2.....	Mar. 8	11.50.....	387	24.955	69	60	5298.5	5351.2	3.45	.....	Cum. coming from southwest; west breeze.
3.....	Mar. 8	2.15.....	387	25.045	68	64					
		2.30.....	387	25.040	66	61	5100.8	5168.6	6.43	.....	Clouds scattering.
4.....	Mar. 8	4.....	387	24.925	67	60	5209.9	5268.6	6.12	.....	Clouds in the horizon to southwest; clear in the zenith.
Camp 28, Rio Mimbres.	Mar. 8	5.30.	387	24.930	55	54	.....	.....	0.39	17	Clear, except in south and southwest; west wind.
		Sunset	387	24.924	50	50	.....	.....	.....	.....	Do.
	Mar. 9	8.15.....	387	25.075	51	49	.....	.....	.....	.....	Clear; fresh northwest wind.
		10.....	387	25.115	63	56	.....	.....	.....	.....	High west wind.
		11.....	387	25.122	63	56	.....	.....	.....	.....	High west wind; a single cloud in southeast horizon.
		12.....	387	25.135	66	59	.....	.....	.....	.....	Do.
		1.....	387	25.142	68	60	.....	.....	.....	.....	High west wind; few cl'ds in south and southeast.

Barometrical Observations and approximate Altitudes, &c.—Continued.

Station.	Date.	Hour.	Number of barometer.	Height of column.	Attached thermometer.	Detached thermometer.	App. altitude, No. 1.	App. altitude, No. 2.	Distance from the preceding station.	Distance from camp to camp.	Remarks.
Camp 28, Rio Mimbres.	Mar. 9	2.....	387	25.142	68	60					
		3.....	387	25.160	69	61					
		4.....	387	25.170	69	61	.....	.....	.....	.....	Wind falling.
		5.....	387	25.175	60	59	.....	.....	.....	.....	Wind falling; clear.
		6.5, or sunset	387	25.168	49	50	5048.4	5082.4	.....	.....	Clear and calm.
1, crossing river.	Mar. 10	6.30, or sunrise.	387	25.370	31	26	4729.8	4602	0.29	.....	Clear and calm.
2.....	Mar. 10	9.30.....	387	25.115	56	49	5092.7	5085.6	7.16	.....	Clear and fresh east wind.
3.....	Mar. 10	10.10.....	387	25.350	57	52	4784.6	4802 2	2	.....	Do.
4.....	Mar. 10	11.50.....	387	25.575	64	58	4579.9	4628.2	2.30	.....	Light east wind.
5.....	Mar. 10	12.30.....	387	25.390	73	62	4782.2	4843.7	2	.....	Do.
6.....	Mar. 10	1.10.....	387	25.225	76	69	4942.6	5045.7	2.20	.....	Do.
7.....	Mar. 10	1 35.....	387	25.390	76	64	4747.2	4827.1	1.30	.....	Do.
Camp 29, Cook's Spring.	Mar. 10	3.....	387	25.385	71	60	.....	.....	0.35	17.60	Clear and light east breeze.
		6, or sunset...	387	25.352	54	53	.....	.....	.....	.....	Clear and calm.
	Mar. 11	11 a. m.....	387	25.312	75	64	.....	.....	.....	.....	Thin. strat. in northeast; light south breeze.
	Mar. 11	11.30.....	387	25.300	72	65	4862.8	4883.2	0.35	17.60	Do.
1.....	Mar. 11	12.50.....	387	25.420	78	71	4781.6	4839.7	3.33	.....	Thin strat. in the horizon; light southwest breeze.
2.....	Mar. 11	3.....	387	25.560	84	76	.....	.....	.....	.....	Thin strat. coming up from south; light southwest breeze.
		3.15.....	387	25.555	83	75	4597.6	4692.5	6.26	.....	Do.
3	Mar. 11	4.30.....	387	25.410	83	76	4754.8	4853.1	3.25	.....	Do.
4.....	Mar. 11	4.45.	387	25.272	80	75	4901.5	4995.3	0.33	.....	Thin strat. in the east and north.
5.....	Mar. 11	6.15, or sunset	387	25.370	62	58	.....	.....	.....	.....	Calm; clouds accumulating in south and east.
		6.30 p. m....	387	25.364	54	54	4751.1	4754.6	4.69	.....	Do.
6, three hundred yards west of camp 30.	Mar. 12	6 a. m.....	387	25.095	44	45	5066.4	5009.7	4.83	.....	Cloudy; calm; rain indications.
Camp 30.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	22.89	
1.....	Mar. 12	7.....	387	25.225	49	49	4968.3	4931.4	3.33	.....	Do.
2.....	Mar. 12	7.30.....	387	25.110	55	55	5113.8	5107.6	1.21	.....	Light southwest breeze.
3.....	Mar. 12	7.45.....	387	25.255	55	54	4955.3	4943.9	0.61	.....	Cloudy and calm.
4.....	Mar. 12	8.....	387	25.320	56	55	4888.5	4881.8	0.70	.....	Do.
5.....	Mar. 12	8.45.....	387	25.420	60	58	4744.1	4800.5	2.49	.....	Cloudy and very light west breeze.
6.....	Mar. 12	10.05.....	387	25.230	61	59	4904.3	5024.6	3.39	.....	Cloudy and very light southwest breeze.
7.....	Mar. 12	12.20.....	387	25.475	64	62	4710	4719.3	6.49	.....	Clouds thickening; fresh south breeze.
8.....	Mar. 12	1.20.....	387	25.210	63	62	4960.9	4989.9	2.44	.....	Clouds thickening; high and fresh.
9..... .	Mar. 12	3.....	387	25.640	70	66	4479.5	4525.4	3.90	.....	Do.
Camp 31, on Rio Bravo.	Mar. 12	5.....	387	25.880	71	66	.....	.....	.....	.....	High southwest wind; clear in the west; clouds in the east.
		6.10, or sunset	387	25.878	60	61	4229.3	4243.7	3.04	27.67	Very blustering; clear in the west; clouds in the east.
Camp 32, near Fort Fillmore.	Mar. 13	2.....	387	26.200	75	75	.....	.....	.....	.....	Cloudy and calm.
		Sunset	387	26.26	58	58	.....	.....	.....	.....	Do.
	Mar. 16	Sunset	387	26.110	73	74	.....	.....	.....	.....	Clouds.
		Sunset	392	26.140	73	74	3937.8	3976	12.28	12.28	
Camp 35.....	Mar. 19	5.45.....	387	25.200	60	59	.....	.....	.....	.....	Westerly breeze; cum. scattering.
		Sunset	387	25.190	56	55	.....	.....	.....	.....	Westerly breeze; few scat. cum.
	Mar. 20	6.15, or sunrise.	387	5.175	31	32	4959.5	4906.8	.....	.....	Clear and calm.
1.....	Mar. 20	9.45.....	387	25. 0	70	69	4458.9	4405	7.60	.....	Clear; light southwest breeze.
2.....	Mar. 20	12.45..... .	387	25.825	73	72					
		1.30.....	387	25.828	77	80	.....	.....	.....	.....	Scattering cum.; strong south-southwest breeze.
		2.....	387	25.820	78	82	4326.2	4418.1	5.75	.....	Do.
Camp 36.....	Mar. 20	6.....	387	25.685	63	62	.....	.....	1	.....	Do.
		Sunset	387	25.660	62	60	4440	4453.5	10.75	24.10	Clear and calm.
1.....	Mar. 21	6.10, or sunrise.	387	25.665	34	33	.....	.....	12.50	.....	Do.
		6.30.....	387	25.665	40	36	4386	4259.4	.....	.....	Do.
2.....	Mar. 21	8.....	387	25.672	60	57	4520.1	4515.7	4.35	.....	Do.
3.....	Mar. 21	11.55.....	387	25.940	80	72	4265.2	4328.6	11.50	.....	Southwest breeze; clouds coming up.
4.....	Mar. 21	1.....	387	26.225	81	79					
		3.....	387	26.214	80	79	3895.7	3988.1	3	....	Southwest breeze; clouds.
Frontera.....	Mar. 24	12.30.....	387	26.230	76	76	3927	3993.3	.....	.....	Do.

APPENDIX.

A.

CAMP NEAR MISSION SAN DIEGO,
December 20, 1853.

SIR: I have the honor to acknowledge the receipt of instructions from the War Department, November 18, 1853, detailing me for the prosecution of a survey "in connection with examination of railroad routes to the Pacific," through Northern Mexico and Texas, together with the passport, and a copy of the instructions relative to the organization of an escort. They arrived at a most opportune moment; Lieut. Williamson about completing his field-work, and Lieut. Stoneman encamped at this place with his escort. Of Lieut. Whipple's movements or whereabouts we have heard nothing definite; and I will, therefore, proceed to organize and equip my party, without counting upon any assistance from the latter officer, receipting to Lieut. Williamson for such instruments and property as I shall need, and at the same time can be spared by him.

But, to complete my outfit, it is absolutely necessary that I should go to San Francisco, mainly to procure barometers. This trip I shall make with all possible despatch.

In my instructions no mention is made of either an assistant or a physician.

Deeming both of these essential to the rapid prosecution of the work and well-being of the expedition, I will secure their services, in case they can be obtained at such salaries as will not cause my expenditures to exceed the amount of appropriation allowed me.

Very respectfully, your obedient servant,

JNO. G. PARKE,
Bvt. 2d Lieut., Corps Top. Engineers.

Hon. JEFFERSON DAVIS,
Secretary of War.

B.

WAR DEPARTMENT,
Washington, December 9, 1853.

SIR: On the eighteenth ultimo, instructions were addressed to you at San Diego, from this department, to make preparations for, and take charge of a survey for a railroad route from a point on the Gila, near the Pimas villages, to the Rio Grande, partly passing through Mexican territory, for which authority had been obtained from the Mexican government. Since those instructions were despatched, intelligence has been received here of a hostile expedition against the Mexican province of Sonora having sailed from California; and it is apprehended that this lawless conduct on the part of our misguided citizens may excite a feeling among the Mexican people which would render it unsafe for your party, with its military escort, to make its appearance among them, especially as it is not known whether the Mexican government has advised its officers or people along the line of your route that the survey is made by permission.

Although the examination of the route in question is a matter of much importance, and earnestly desired by the department, it is unwilling to incur any serious risk of a collision between your party and the Mexicans. You are, therefore, directed to consider well all the circumstances before proceeding to carry into effect the instructions above referred to; and unless you are fully satisfied that you can perform the exploration without any serious interruption, you will relinquish the undertaking for the present. With this general direction, the matter must be left to your discretion, with the injunction to let no undue confidence lead you to overlook or underrate the possible danger before you; and as you will, when these instructions reach you, be in possession of information later, by from thirty to sixty days, than that which has reached this city, it is to be hoped that it may be of such a character as will enable you to form a correct and safe conclusion as to the course to be pursued.

Very respectfully, your obedient servant,

JEFFERSON DAVIS,
Secretary of War.

Lieut. JOHN G. PARKE,
Corps Topographical Engineers.

P. S.—Accompanying your instructions was sent a passport from the State Department, which it was intended to have countersigned by the Mexican minister. His absence, however, prevented it. Herewith you will find a duplicate with the countersign of General Almonte.

INDEX.

	Page
Apache Indians	7
visits from	10
family of, mounted.	11
Almonte, General	20
Backus, Major E	14
Blodget, L	19
letter from, to Lieut. J. G. Parke	20
Barometrical measurements with reduced approximate altitudes	19, 21 to 24
Custer, Henry	4, 19
Cottonwood, first appearance after leaving the Gila	4
Chiricahui mountains	9, 11
Characteristics of valleys	12
Cook's trail	11
Chandler, Mr	20
Davis, Jefferson, (Secretary of War,) instructions to Lieut. J. G. Parke	3, 26
letter to, from Lieut. Parke.	26
Dos Cabezas	8
Doña Ana	14
El Picacho mountains	6, 7
Emory, Major W. H	15, 20
Fort Webster, startling intelligence from.	13
Fort Fillmore	17
Gila river	5
Garcia, Captain Hilarion	7, 8
Gomez, Captain Bernabé	7, 8
Heerman, Dr. A. L	4, 19
Hostile expedition against a Mexican province	6, 26
Indians, Pimas	5
Maricopas	5
Apaches	7, 10, 11
Letters, Secretary of War to Lieut. Parke	3, 25
Lieut. Parke to Secretary of War	25
L Blodget to Lieut. Parke	20
Maricopas Indians	5
villages	5
Meteorite found in cañon of Santa Rita mountain	7
analysis by Prof. Shepard	7
Mount Graham	9
Mesilla valley	14
Mesilla	14
McFerren, Lieut. J. C	14
Map of the route, explanation of	15
Major, D. G	20
Nugent, Mr	5, 9, 11
Ojo de Vaca	12
Pimas Indians	5
villages	5
Playa de los Pimas	9
Puerto del Dado	9
Pope, Captain	15

	Page.
Profile of route	15
Rio Mimbres	13
Rio Bravo del Norte	14
Ransom, Lieut. R	14
Stoneman, Lieut. George	4, 7, 9, 11, 19
Sierra Santa Catarina	7
Sierra Santa Rita	7
Shepard, Prof. Charles U	7
San Javier del Bac	7
San Pedro river	8
Salt Lake	9
Sauz valley	10
Smithsonian Institution	19
Tucson	6, 7
inhabitants	7
Williamson, Lieut. R. S	3, 4, 25
Whipple, Lieut. A. W	3, 19, 20, 25

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

ROUTE NEAR THE THIRTY-SECOND PARALLEL OF NORTH LATITUDE.

EXTRACT

FROM

REPORT OF A MILITARY RECONNAISSANCE,

MADE IN 1846 AND 1847,

BY

LIEUT. COL. W. H. EMORY.

Sir: For the purpose of giving completeness to the railroad reports of the route near the thirty-second parallel, the following extract is made from the report by Lieut. Col. Emory, of his reconnaissance in 1846 and 1847, from Fort Leavenworth, Missouri, to San Diego, California.

The extract is from that portion of the report describing the route from the junction of the San Pedro with the Gila, to the junction of the latter with the Colorado of the West.

This connects Lieutenant Parke's survey (from Doña Ana to the Pimos villages) with Lieutenant Williamson's surveys in the southern part of the State of California.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,

Captain Topographical Engineers.

Hon. Jefferson Davis,

Secretary of War.

EXTRACT FROM LT. COL. EMORY'S REPORT.

From the junction of the San Pedro with the Gila, to the junction of the Gila with the Colorado of the West.

Junction of the San Pedro and Gila rivers.—Formation along the Gila.—Stormy night.—Visits from Indians.—Game.—Minerals.—Willows.—Formation of rocks.—Plants.—Atmosphere.—Soil.—Remains of Indian settlements.—Hieroglyphics.—Pimos Indians.—Tradition.—Manner of cultivating land.—Dress.—Traffic.—Character of the Pimos Indians; their advancement in civilization.—Depredations of Apache Indians.—Maricopas Indians; their character, &c.—Maricopas women.—Mirage.—Scarcity of grass and water.—Loss of mules.—Remains of Indian works.—Hieroglyphics.—Game.—Mexican camp; capture of the party with their horses.—Navigation of the Colorado and Gila rivers.—Remains of a Spanish church.—Settlers.—Capture of a Mexican with the mail from California; interesting news.—Lassoing horses.—General sketch of the country from the Arkansas to the Colorado.—Mexican peonage.—Apaches and Navajoes.—Colorado river.

About two miles from our camp the San Pedro joins the Gila, just as the latter leaps from the mouth of the cañon. The place of meeting is a bottom three miles wide, seeming a continuation of that of the Gila. It is principally of deep dust and sand, overgrown with cotton-wood, mezquite, chamiza, willow, and the black willow. In places there are long sweeps of large paving-pebbles, filled up with drift-wood, giving the appearance of having been overflowed by an impetuous torrent. The hills on both sides of the river, still high, but now farther off, and covered to the top with soil producing the mezquite and pitahaya, as the day advanced, began to draw in closer, and before it closed had again contracted the valley to a space little more than sufficient for the river to pass; and at halt, after making seventeen miles, we found ourselves encompassed by hills much diminished in height, but not in abruptness. The road, except the deep dust which occasionally gave way and lowered a mule to his knee, was good—that is, there were no hills to scale. The river was crossed and recrossed four times. At twelve and fourteen miles there were good patches of grama, burned quite yellow, but for most of the way, and at our camp, there was little or no grass, and our mules were turned loose to pick what they could of rushes and willow along the margin of the stream.

Wherever the formation was exposed along the river, it was a conglomerate of sandstone, lime, and pebbles, with deep caverns.

Nearly opposite our camp of this date, and about one-third the distance up the hill, there crop out ore of copper and iron, easily worked, the carbonate of lime and calcareous spar. A continuation of the vein of ore was found on the side where we encamped, and a large knoll strewed with what the Spaniards call "*guia*," the English of which is "guide to gold."

The night has set in dark and stormy; the wind blows in gusts from the southwest, and the rain, falling in good earnest, mingled with the rustling noise of the Gila, which has now become swift and impetuous, produces on us, who have so long been accustomed to a tranquil atmosphere, quite the impress of a tempest. We have been so long without rain as to cease to expect, or make provision against it; and the consequence is, the greatest difficulty in getting the men to provide coverings for the destructible portion of our rations.

Three Indians hailed us just before making camp, and after much parley were brought in. They feasted heartily, and promised to bring in mules. At first they denied having any; but after their appetites were satisfied their hearts opened, and they sent the youngest of their party to their town, which was at the head of the dry creek of our camp of the night before last. The fellow went on his way, as directed, till he met the howitzers, which so filled him with surprise and consternation that he forgot his mission and followed the guns to camp in mute wonder. These people are of the Piñon Lano (piñon wood) tribe, and we had been told by the Pinoleros (pinole eaters) that the chief of this band had mules.

Flights of geese and myriads of the blue quail were seen, and a flock of turkeys, from which we got one.

The river-bed at the junction of the San Pedro was seamed with tracks of deer and turkeys; some signs of beaver, and one trail of wild hogs.

Our camp was on a flat, sandy plain, of small extent, at the mouth of a dry creek with deep washed banks, giving the appearance of containing, at times, a rapid and powerful stream, although no water was visible in the bed. At the junction, a clear, pure stream flowed from under the sand. From the many indications of gold and copper ore at this place, I have named it Mineral creek; and, I doubt not, a few years will see flat-boats descending the river from this point to its mouth, freighted with its precious ores.

There was a great deal of pottery about our camp, and just above us were the supposed remains of a large Indian settlement, differing very slightly from those already described.

November 8.—The whole day's journey was through a cañon, and the river was crossed twelve or fifteen times. The sand was deep, and occasionally the trail much obstructed by pebbles of paving-stone. The willow grew so densely in many places as to stop our progress, and oblige us to look for spots less thickly overgrown, through which we could break.

The precipices on each side were steep; the rock was mostly granite and a compact sandy limestone, with occasional seams of basalt and trap; and towards the end of the day, calcareous sandstone, and a conglomerate of sandstone, feldspar, fragments of basalt, pebbles, &c. The stratification was very confused and irregular, sometimes perfectly vertical, but mostly dipping to the southwest, at an angle of 30°. Vast boulders of pure quartz at times obstructed our way, and the river in places was paved with those of less magnitude.

About two miles from camp our course was traversed by a seam of yellowish-colored igneous rock, shooting up into irregular spires and turrets, one or two thousand feet in height. It ran at right angles to the river, and extended to the north and to the south, in a chain of mountains as far as the eye could reach. One of these towers was capped with a substance, many hundred feet thick, disposed in horizontal strata of different colors, from deep red to light yellow. Partially disintegrated, and lying at the foot of the chain of spires, was a yellowish calcareous sandstone, altered by fire, in large amorphous masses.

For a better description of this landscape, see the sketch by Mr. Stanly.

To the west, about a mile below us, and running parallel to the first, is another similar seam, cut through by the Gila, at a great butte, shaped like a house. The top of this butte appears to have once formed the table-land, and is still covered with vegetation. Through both these barriers the river has been conducted by some other means than attrition. Where it passes the first, it presents the appearance of a vast wall torn down by blows of a trip-hammer. Under to-day's date, in Appendix No. 2, will be found many interesting plants, but the principal growth was, as usual, pitahaya, acacia, prosopis, Fremontia and obione canescens.

The latitude of this camp, which is within a mile of the spot where we take a final leave of the mountains, is, by the mean of the observations on north and south stars, Polaris and beta Aquarii, 33° 05′ 40″; and the height of the river at this point above the sea, as indicated by the barometer, 1,751 feet.

At night, for the first time since leaving Pawnee fork, I was interrupted for a moment in my observations by moisture collecting on the glass of my horizon shade, showing a degree of

humidity in the atmosphere not before existing. In the States there is scarcely a night when the moisture will not collect on the glass exposed to the air, sufficient in two or three minutes to prevent the perfect transmission of light.

November 9.—The effect of last night's dampness was felt in the morning, for, although the thermometer was only 37°, the cold was more sensible than in the dry regions at 25°.

We started in advance of the command to explore the lower belt of mountains by which we were encompassed. The first thing we noticed in the gorge was a promontory of pitch-stone, against which the river impinged with fearful force, for it was now descending at a rapid rate. Mounting to the top of the rock, on a beautiful table, we found sunk six or eight perfectly symmetrical and well-turned holes, about ten inches deep and six or eight wide at top; near one, in a remote place, was a pitch-stone, well turned and fashioned like a pestle. These could be nothing else than the corn-mills of long extinct races. Above this bed of pitch-stone a butte of calcareous sandstone shot up to a great height, in the seams of which were imbedded beautiful crystals of quartz. Turning the sharp angle of the promontory, we discovered a high perpendicular cliff of calcareous spar and baked argillaceous rock, against which the river also abutted, seamed so as to represent distinctly the flames of a volcano. A sketch was made of it, and is presented with these notes. On the side of the river opposite the igneous rocks, the butte rose in perpendicular and confused masses.

This chain continued, not parallel, as I supposed, to the first described barrier, but circled round to the east, and united with it. It also united on the north side, forming a basin three or four miles in diameter, in which we encamped last night. Except a few tufts of larrea Mexicana, these hills were bare of vegetation. Away off to the south, and bordering on the banks of the river, covering the surface of the ground for one or two feet, was an incrustation of black cellular lava or basalt, like that seen about the Raton. Nothing more was wanted to give the idea of an immense extinct volcano. Through the centre of the crater the Gila now pursues its rapid course.

The Gila at this point, released from its mountain barrier, flows off quietly at the rate of three miles an hour into a wide plain, which extends south almost as far as the eye can reach. Upon this plain mezquite, chamiza, the green acacia, prosopis, artemisia, obione canescens, and pitahaya, were the only vegetation. In one spot only we found a few bunches of grass. More than four-fifths of the plain was destitute of vegetation; the soil, a light-brown, loose, sandy earth, I supposed contained something deleterious to vegetation.*

We made our noon halt at the grass patch. At this place were the remains of an immense Indian settlement; pottery was everywhere to be found, but the remains of the foundations of the houses were imbedded in dust. The outlines of the acequias, by which the soil was irrigated, were sometimes quite distinct.

The soil was moist, and wherever the foot pressed the ground the salts of the earth effloresced, and gave it the appearance of being covered with frost. In this way the numberless tracks of horses and other animals, which had at times traversed the plains, were indelible, and could be traced for great distances by the eye, in long white seams.

We found fresh trails of horses, which might be those of General Castro, or of the Indians. When leaving California, Castro's determination, as we learn from Carson, was to go to Sonora, beat up recruits and return. Our route might easily be reached, for we are now marching along a road everywhere accessible, and within three days' march of the settlements of Sonora and the fort at Tucson, said to be regularly garrisoned by Mexican soldiers.

We passed the deserted lodges of Indians, and, at one place, remote from the lodges, we saw thirteen poles set up in a sort of incantation formula—twelve on the circumference of a circle

* A specimen of this soil was submitted to Professor Fraser, who says: "It is a light-brown, loose, sandy earth, containing scarcely anything soluble in water, the solution giving only faint indications of common salt and carbonite of lime. A very small portion of iron pyrites is also contained in it, but I imagine its want of fertility may more properly be attributed to its deficiency in organic matters."

twenty feet in diameter, and one in the centre. Radii were drawn on the ground from the centre pole to those in the periphery of the circle. It was the figuring of some medicine man of the Apaches or Pimos, we could not tell which, for it was on neutral ground, about the dividing line of the possessions claimed by each.

After leaving the mountains all seemed for a moment to consider the difficulties of our journey at an end. The mules went off at a frolicsome pace, those which were loose contending with each other for precedence in the trail. The howitzers, which had nearly every part of their running gear broken and replaced, were, perhaps, the only things that were benefited by the change from the mountains to the plains. These were under the charge of Lieutenant Davidson, whose post has been no sinecure. In overcoming one set of difficulties we were now to encounter another. In leaving the mountains we were informed that we bade adieu to grass, and our mules must henceforth subsist on willow, cotton-wood, and the long green ephedra.

November 10.—The valley on the southern side of the Gila still grows wider. Away off in that direction the peaks of the Sonora mountains just peep above the horizon. On the north side of the river, and a few miles from it, runs a low chain of serrated hills. Near our encampment a corresponding range draws in from the southeast, giving the river a bend to the north. At the base of this chain is a long meadow, reaching for many miles south, in which the Pimos graze their cattle; and along the whole day's march were remains of zequias, pottery, and other evidences of a once densely populated country. About the time of the noon halt, a large pile, which seemed the work of human hands, was seen to the left. It was the remains of a three-story mud house, sixty feet square, pierced for doors and windows. The walls were four feet thick, and formed by layers of mud two feet thick. Stanly made an elaborate sketch of every part; for it was, no doubt, built by the same race that had once so thickly peopled this territory, and left behind the ruins.

We made a long and careful search for some specimens of household furniture or implement of art, but nothing was found except the corn-grinder, always met with among the ruins and on the plains. The marine shell, cut into various ornaments, was also found here, which showed that these people either came from the seacoast or trafficked there. No traces of hewn timber were discovered; on the contrary, the sleepers of the ground-floor were round and unhewn. They were burnt out of their seats in the wall to the depth of six inches. The whole interior of the house had been burnt out, and the walls much defaced. What was left bore marks of having been glazed, and on the wall in the north room of the second story were traced the following hieroglyphics: [Lost.]

Where we encamped, eight or nine miles from the Pimos village, we met a Maricopa Indian looking for his cattle. The frank, confident manner in which he approached us was in strange contrast with that of the suspicious Apache. Soon six or eight of the Pimos came in at full speed. Their object was to ascertain who we were, and what we wanted. They told us the fresh trail we saw up the river was that of their people, sent to watch the movements of their enemies, the Apaches. Being young, they became much alarmed on seeing us, and returned to the town, giving the alarm that a large body of Apaches were approaching.

Their joy was unaffected at seeing we were Americans, and not Apaches. The chief of the guard at once despatched news to his chief of the result of his reconnaissance. The town was nine miles distant, yet in three hours our camp was filled with Pimos, loaded with corn, beans, honey, and zandias (water-melons.) A brisk trade was at once opened. This was my observing night; but the crowd of Indians was great, and the passing and repassing at full speed so continuous, that I got an indifferent set of observations.

The camp of my party was pitched on the side nearest the town, and we saw the first of these people and their mode of approach. It was perfectly frank and unsuspicious. Many would leave their packs in our camp and be absent for hours, theft seeming to be unknown among them. With the mounted guard, which first visited us, was a man on foot, and he appeared to keep pace with the fleetest horse. He was a little out of breath when he reached

us; but soon recovering, told us he was interpreter to Juan Antonio Llunas, chief of the Pimos. We were taking some refreshments at the time, and invited him to taste of them. The effect was electric; it made his bright, intelligent eye flash, and loosened his tongue. I asked him, among other things, the origin of the ruins of which we had seen so many. He said, all he knew was a tradition amongst them, "that in by-gone days a woman of surpassing beauty resided in a green spot in the mountains near the place where we were encamped. All the men admired and paid court to her. She received the tributes of their devotion—grain, skins, &c., but gave no love or other favor in return. Her virtue and her determination to remain unmarried were equally firm. There came a drought which threatened the world with famine. In their distress people applied to her, and she gave corn from her stock, and the supply seemed to be endless. Her goodness was unbounded. One day as she was lying asleep with her body exposed, a drop of rain fell on her stomach, which produced conception. A son was the issue, who was the founder of a new race, which built all these houses."

I told the interpreter repeatedly he must go and report to the general; but his answer was, "Let me wait till I blow a little." The attraction was the aguardiente. At length he was prevailed on to go to head-quarters, leaving at our camp his bows and arrows and other matters, saying he would return and pass the night with us.

November 11.—Leaving the column, a few of us struck to the north side of the river, guided by my loquacious friend, the interpreter, to visit the ruins of another Casa Montezuma. In the course of the ride I asked him if he believed the fable he had related to me last night, which assigned an origin to these buildings. "No," said he, "but most of the Pimos do. We know, in truth, nothing of their origin. It is all enveloped in mystery."

The casa was in complete ruins, one pile of broken pottery and foundation-stone of the black basalt making a mound about ten feet above the ground. The outline of the ground-plan was distinct enough.

We found the description of pottery the same as ever, and among the ruins the same sea-shell, one worked into ornaments; also a large bead, an inch and a quarter in length, of bluish marble, exquisitely turned.

We secured to-day our long-sought bird, the inhabitant of the mezquite, indigo-blue plumage, with top-knot and long tail; its wings, when spread, showing a white ellipse.

Turning from the ruins towards the Pimos village, we urged our guide to go fast, as we wished to see as much of his people as the day would permit. He was on foot, but led at a pace which kept our mules in a trot.

We came in at the back of the settlement of the Pimos Indians, and found our troops encamped in a cornfield, from which the grain had been gathered. We were at once impressed with the beauty, order, and disposition of the arrangements for irrigating and draining the land. Corn, wheat, and cotton are the crops of this peaceful and intelligent race of people. All the crops have been gathered in, and the stubbles show they have been luxuriant. The cotton has been picked and stacked for drying on the tops of sheds. The fields are subdivided by ridges of earth into rectangles of about 200 × 100 feet, for the convenience of irrigating. The fences are of sticks, wattled with willow and mezquite, and, in this particular, set an example of economy in agriculture worthy to be followed by the Mexicans, who never use fences at all. The houses of the people are mere sheds, thatched with willow and corn-stalks.

With the exception of the chief, Antonio Llunas, who was clad in cast-off Mexican toggery, the dress of the men consisted of a cotton serape of domestic manufacture, and a breech-cloth. Their hair was very long and clubbed up. The women wore nothing but the serape pinned about the loins, after the fashion of Persico's Indian woman on the east side of the Capitol, though not quite so low.

The camp was soon filled with men, women, and children, each with a basket of corn, frijolés, or meal, for traffic. Many had jars of the molasses expressed from the fruit of the pitahaya. Beads, red cloth, white domestic, and blankets, were the articles demanded

in exchange. Major Swords, who had charge of the trading duty, pitched a temporary awning under which to conduct the business, which had scarcely commenced before this place formed a perfect menagerie, into which crowded, with eager eyes, Pimos, Maricopas, Mexicans, French, Dutch, English, and Americans. As I passed on to take a peep at the scene, naked arms, hands, and legs protruded from the awning. Inside there was no room for bodies, but many heads had clustered into a very small space, filled with different tongues and nations. The trade went merrily on, and the conclusion of each bargain was announced by a grunt and a joke, sometimes at the expense of the quartermaster, but oftener at that of the Pimos.

November 12.—We procured a sufficiency of corn, wheat, and beans from the Pimos, but only two or three bullocks, and neither horses nor mules. They have but few cattle, which are used in tillage, and apparently all steers, procured from the Mexicans. Their horses and mules were not plenty, and those they possessed were prized extravagantly high. One dashing young fellow, with ivory teeth and flowing hair, was seen coming into our camp at full speed, on a wild, unruly horse, that flew from side to side as he approached, alarmed at the novel apparition of our people. The Maricopa—for he was of that tribe—was without saddle or stirrups, and balanced himself to the right and left with such ease and grace as to appear part of his horse. He succeeded in bringing his fiery nag into the heart of the camp. He was immediately offered a very advantageous trade by some young officer. He stretched himself on his horse's neck, caressed it tenderly, at the same time shutting his eyes, meaning thereby that no offer could tempt him to part with his charger.

The general gave a letter to Governor Llunas, stating that he was a good man, and directing all United States troops that might pass in his rear to respect his excellency, his people, and their property. Several broken-down mules were left with him to recruit, for the benefit of Cook's battalion as it should pass along.

To us it was a rare sight to be thrown into the midst of a large nation of what are termed wild Indians, surpassing many of the Christian nations in agriculture, little behind them in the useful arts, and immeasurably before them in honesty and virtue. During the whole of yesterday our camp was full of men women, and children, who sauntered amongst our packs unwatched, and not a single instance of theft was reported.

I rode leisurely in the rear, through the thatched huts of the Pimos. Each abode consists of a dome-shaped wicker-work, about six feet high, and from twenty to fifty feet in diameter, thatched with straw or corn-stalks. In front is usually a large arbor, on top of which is piled the cotton in the pod for drying.

In the houses were stowed watermelons, pumpkins, beans, corn, and wheat, the last three articles generally in large baskets; sometimes the corn was in baskets covered with earth, and placed on the tops of the domes. A few chickens and dogs were seen, but no other domestic animals except horses, mules, and oxen. Their implements of husbandry were the axe, (of steel,) wooden hoes, shovels, and harrows. The soil is so easily pulverized as to make the plough unnecessary.

Several acquaintances, formed in our camp yesterday, were recognised, and they received me cordially, made signs to dismount, and when I did so, offered watermelons and pinole. Pinole is the heart of Indian corn, baked, ground up, and mixed with sugar. When dissolved in water, it affords a delicious beverage; it quenches thirst, and is very nutritious. Their molasses, put up in large jars hermetically sealed, of which they had quantities, is expressed from the fruit of the pitahaya.

A woman was seated on the ground under the shade of one of the cotton sheds. Her left leg was tucked under her seat, and her foot turned sole upwards; between her big toe and the next was a spindle about eighteen inches long, with a single fly of four or six inches. Ever and anon she gave it a twist in a dexterous manner, and at its end was drawn a coarse cotton thread. This was their spinning jenny. Led on by this primitive display, I asked for their loom by pointing to the thread and then to the blanket girded about the woman's loins. A fellow

stretched in the dust, sunning himself, rose up leisurely and untied a bundle which I had supposed to be a bow and arrow. This little package, with four stakes in the ground, was the loom. He stretched his cloth and commenced the process of weaving.

We travelled fifteen and a half miles and encamped on the dividing ground between the Pimos and Maricopas. For the whole distance we passed through cultivated grounds, over a luxuriantly rich soil. The plain appeared to extend in every direction fifteen or twenty miles, except in one place about five miles before reaching camp, where a low chain of hills comes in from the southeast, and terminates some miles from the river. The bed of the Gila, opposite the village, is said to be dry, the whole water being drawn off by the acequias of the Pimos for irrigation; but the ditches are larger than is necessary for this purpose, and the water which is not used returns to the bed of the river with little apparent diminution in its volume.

Looking from our camp north, 30° west, you see a great plain, with mountains rising in the distance on each side. This prospect had induced some travellers to venture from here in a direct line to Monterey, in California, but there is neither grass nor water on that passage, and thirst and distress overcame, undoubtedly, those who attempted it.

In almost an opposite direction north, 50° east, there is a gap in the mountains, through which the Salt river flows to meet the Gila, making with it an acute angle at a point ten or fifteen miles distant from our camp, bearing northwest. A little north of east, another gap, twenty or thirty miles distant, shows where the Rio San Francisco flows into the Salt river. From the best information I can collect, the San Francisco comes in from the north; its valley is narrow and much cañoned; good grass abounds all the way. Le Vonoceur, one of my party, came down that river in 1844 with a trapping party of forty-eight men. He states that they were much annoyed the whole way by the Apache Indians, a great many of whom reside on that river. Every night they were fired upon, and an attempt made to stampede their mules. Many of their traps were stolen, and one of their party, an old man, who had been in the mountains forty-five years, was killed by the Indians in this expedition.

Near the junction of the Gila and Salt rivers there is a chain of low serrated hills coming in from both sides, contracting the valley considerably. Around the south spur the Gila turns, making its course in a more southerly direction. To the east, except where the spurs already mentioned protrude, the plain extends as far as the eye can reach. A great deal of the land is cultivated, but there is still a vast portion within the level of the Gila that is yet to be put under tillage. The population of the Pimos and Maricopas together is estimated variously at from three to ten thousand. The first is evidently too low.

This peaceful and industrious race are in possession of a beautiful and fertile basin. Living remote from the civilized world, they are seldom visited by whites, and then only by those in distress, to whom they generously furnish horses and food. Aguardiente (brandy) is known among their chief men only, and the abuse of this, and the vices which it entails, are yet unknown.

They are without other religion than a belief in one great and overruling spirit.

Their peaceful disposition is not the result of incapacity for war, for they are at all times enabled to meet and vanquish the Apaches in battle, and when we passed they had just returned from an expedition in the Apache country to revenge some thefts and other outrages, with eleven scalps and thirteen prisoners. The prisoners are sold as slaves to the Mexicans.

The Maricopas occupy that part of the basin lying between camp 97 and the mouth of the Salt river, and all that has been said of the Pimos is applicable to them. They live in cordial amity, and their habits, agriculture, religion, and manufactures, are the same. In stature they are taller; their noses are more aquiline, and they have a much readier manner of speaking and acting. I noticed that most of the interpreters of the Pimos were of this tribe, and also the men we met with in the spy-guard. Though fewer in number, they appear to be superior in intelligence and personal appearance.

Don José Messio is their governor, and, like the governor of the Pimos, holds his office by

the appointment of the Mexican governor of California. The people have no choice in the selection. Both of these Indians are respectable-looking old men, and seem to be really worthy of the trust reposed in them.

We had not been long in camp before a dense column of dust down the river announced the approach of the Maricopas, some on foot, but most of them on horseback. They came into camp at full speed, unarmed, and in the most confident manner, bringing watermelons, meal, pinole, and salt for trade. The salt is taken from the plains ; wherever there are bottoms which have no natural drainage, the salt effloresces, and is skimmed from the surface of the earth. It was brought to us both in the crystallized form and in the form when first collected, mixed with earth.

My camp was selected on the side towards the village, and the constant galloping of horses rendered it difficult for me to take satisfactory observations, which I was desirous of doing, as it is an important station. When I placed my horizon on the ground, I found that the galloping of a horse five hundred yards off affected the mercury, and prevented a perfectly reflected image of the stars, and it was vain to hope for these restless Maricopas to keep quiet. News got about of my dealings with the stars, and my camp was crowded the whole time.

The latitude of this camp, by such observations as the Maricopas would allow me to make, was 33° 09′ 28″.

November 13 *and* 14.—With the morning came the Maricopas women, dressed like the Pimos. They are somewhat taller, and one peculiarity struck me forcibly—that while the men had aquiline noses, those of the women were *retroussés.* Finding the trade in meal had ceased, they collected in squads about the different fires, and made the air ring with their jokes and merry peals of laughter. Mr. Bestor's spectacles were a great source of merriment. Some of them formed the idea, that with their aid he could see through their cotton blankets. They would shrink and hide behind each other at his approach. At length I placed the spectacles on the nose of an old woman, who became acquainted with their use, and explained it to the others.

We were notified that a long journey was to be made without finding water, (to cut off an elbow in the river,) and the demand for gourds was much greater than the supply. One large gourd cost me four strings of glass beads, which was thought a high price. The interpreter who guided us to the Casa Montezuma, on the north side of the Gila, said that on the Salt river, about one and a half day's journey, there was one of those buildings standing, complete in all respects except the floors and roof. He said it was very large, with beautiful glazed walls; that the footsteps of the men employed in building the house could yet be seen in the adobe, and that the impression was that of a naked foot. Whenever a rain comes, the Indians resort to these old houses to look for trinkets of shells and a peculiar green stone, which I think is nothing more than verde antique.

At 12 o'clock, after giving our horses a last watering, we started off in a southwestern direction to turn the southern foot of the range of hills pointing to the Salt river. Five miles brought us into a grove of the pitahaya, which had yielded a plentiful supply of fruit to the Indians. Our way was over a plain of granitic sand, ascending gradually and almost imperceptibly. After leaving the pitahaya, there was no growth except the larrea Mexicana, and occasionally, at long intervals, an acacia or inga.

We travelled till long after dark, and dropped down in a dust-hole near two large, green-barked acacias. There was not a sprig of grass or a drop of water, and during the whole night the mules kept up a piteous cry for both.

There was nothing but the offensive larrea, which even mules will not touch when so hungry as to eat with avidity the dry twigs of all other shrubs and trees. As soon as the moon rose, at 3 a. m., the bugle sounded to horse, and we were up and pursuing our way. A little after sunrise we had passed the summit, and were descending towards the Gila. This summit was formed by a range of granite hills running southeast, and standing in pinnacles.

As the sun mounted, the mirage, only seen once before since leaving the plains of the Arkansas, now began to distort the distant mountains, which everywhere bounded the horizon, into many fantastic shapes. The morning was sharp and bracing, and I was excessively hungry, having given my breakfast, consisting of two biscuits, to my still more hungry mule. I was describing to Mr. Warner how much more pleasant it would be to be jogging into Washington after a fox hunt, with the prospect of a hot breakfast, when up rose to our astonished view, on the north side of the Gila, a perfect representation of the Capitol, with dome, wings, and portico, all complete. It remained for full twenty minutes with its proportions and outline perfect, when it dwindled down into a distant butte.

We went on briskly to the Gila, whose course, marked by the green cotton-wood, could be easily traced. It looked much nearer than it really was. We reached it after making forty miles from our camp of yesterday.

Our poor brutes were so hungry they would drink no water, but fell to work on the young willows and cane. After letting them bite a few minutes we moved down the river five miles farther, to a large and luxuriant patch of paspalum grass, shaded by the acacia and prosopis.

My eyes becoming sore with dust, I took a large object for my southern star to-night, the planet Saturn. Sixteen circum-meridian altitudes of Saturn, and nine altitudes of Polaris, give the latitude of the camp 35° 59′ 22″.

November 15.—In the morning the general found the mules so much worsted by the forty-five miles' journey without food or water, that he determined to remain for the day. Most of the mules belonging to my party have travelled 1,800 miles, almost continously. Two or three times they have all appeared on the eve of death; but a mule's vitality recuperates when life seems to be almost extinct, so I am in hopes the day's rest will revive them sufficiently to enable them to undertake what will be the most distressing part of the journey. From information collected from the Indians and others, it appears that we shall meet with no more grass from this spot to the settlements, estimated to be three hundred miles distant.

This has been a gloomy day in the dragoon camp. The jornada cost them six or eight mules, and those which have survived give little promise of future service. The howitzers make severe draughts on them. Yesterday, within five miles of the river, Lieutenant Davidson was obliged to hitch his private mules to them. An order has been given to-day to dismount one-half the command and reserve the animals for packing.

From all accounts there is no difficulty in following the route of the river from camp 97 to this place, and the journey is but a trifle longer; I would, therefore, recommend parties in our rear to get a Coco Maricopa guide and keep the river.

Our trail crossed the remains of an old acequia, and the plains were covered with broken pottery. About us there are signs of modern Indian tenements, and the acequia may possibly have been the work of their hands. We know the Maricopas have moved gradually from the gulf of California to their present location, in juxtaposition with the Pimos. They were found so late as the year 1826 at the mouth of the Gila; and Dr. Anderson, who passed from Sonora to California in 1828, found them, as near as we could reckon from his notes, about the place we are now encamped in. The shells found to-day were, in my opinion, evidently brought by the Maricopas from the sea. They differ from those we found among the ruins.

Observed for time to-night and obtained the rates of my chronometers; that of chronometer No. 783, 12*s*. per day, showing a very satisfactory consistency in rate since leaving the mountains.

November 16.—The valley on the south side continues wide, and shows continuously the marks of former cultivation. On the north side the hills run close to the river.

After making ten miles we came to a dry creek, coming from a plain reaching far to the south, and then we mounted the table-lands to avoid a bend in the river, made by a low chain of black hills coming in from the southeast. The table-land was strewed with fragments of

black basalt, interspersed with agate, chalcedony, vitrified quartz, and carbonate of lime. About the summit was a mound of granite boulders, blackened by augite, and covered with unknown characters, the work of human hands. These have been copied. On the ground near by were also traces of some of the figures, showing some of the hieroglyphics, at least, to have been the work of modern Indians. Others were of undoubted antiquity, and the signs and symbols intended, doubtless, to commemorate some great event. One stone bore on it what might be taken, with a little stretch of the imagination, to be a mastodon, a horse, a dog, and a man. Their heads are turned to the east, and this may commemorate the passage of the Aborigines of the Gila on their way south.

Many of the modern symbols are in imitation of the antique, and doubtless the medicine men of the present day resort to this mound to invoke their unseen spirits, and work the miracles which enable them to hold their sway amongst their credulous race. There are many more weird and mysterious-looking places than this to be found along the banks of the Gila, and the first attraction to the modern Indian was, without doubt, the strange characters he saw inscribed.

Some of the boulders appear to have been written and re-written upon so often, it was impossible to get a distinct outline of any of the characters.

We descended into the broad valley of the Gila, skirted on the south side by the table-land, black with basalt pebbles, resting on a stratum of the carbonate of lime, upon which the river impinged at every flood and widened its valley.

The hills on the north side were of red and gray rocks, probably granite, irregular in form, varying from five hundred to one thousand feet. Finding no grass, we loosened our mules among the willows and cane.

November 17.—The route to-day was over a country much the same as that described yesterday. Wherever we mounted to the table-lands to cut off a bend in the river, we found them dreary beyond description, covered with blocks of basalt, with a few intervals of dwarf growth of larrea. Now and then a single acacia raised its solitary form and displayed its verdure in the black expanse. We crossed the dry beds of two creeks with sandy bottoms. Under the crust of basalt are usually sandstone and a conglomerate of pebbles, sandstone, and lime. This last is easily undermined by the river, and the basalt or lava then caves in.

The bottoms of the river are wide, rich, and thickly overgrown with willow and a tall aromatic weed, and alive with flights of white brant, (wing tipped with black,) geese, and ducks, with many signs of deer and beaver.

At night I heard the song of the sailors calling the depth of the water, and presently Williams, Lieutenant Warner's servant, who had been missing all day, came out of the river with the hind quarters of a large buck, perfectly intoxicated with his unexpected success. Twelve miles back he let his mule loose, went in pursuit of deer, and killed a buck. After lugging the whole of it for two miles, he lightened his load by leaving one-half.

We encamped down in one of the deserted beds of the Gila, where the ground was cracked and drawn into blisters. The night was cold, the thermometer at 6 a. m. 20°. Latitude of the camp 32° 55′ 52″.

November 18.—High wind from the northwest all day, showing that there was still a barrier of snow-clad mountains between ourselves and Monterey, which we must turn or scale.

Carson pointed to a flat rock covered with fir, and told that he had slaughtered a fat mule there. The names of several Americans were inscribed on the same rock.

After travelling some ten or twelve miles through the valley, we mounted to the table-land, and at 12½ o'clock stopped to graze our horses at a little patch of dried spear-grass. Leaving this, the ground, as far as the eye could reach, was strewn with the black, shining, well-rounded pebbles. The larrea even was scarcely seen, and dreariness seemed to mantle the earth. The arroyo by which we descended to the river was cut from a bed of reddish pebbles twenty or

thirty feet deep, and as we neared the river they were soldered together into a conglomerate, of which lime was the cement.

We saw to-day on the rocks other rude carvings of the Indians, but their modern date was apparent.

To-day there was a dead calm, about meridian intensely hot, and the dust rose in volumes as our party advanced.

We found the river spread over a greater surface—about one hundred yards wide—and flowing gently along over a sandy bottom, the banks fringed with cane, willow, and myrtle.

Last night I took an involuntary plunge into it, for my mule sunk in a quicksand while I was searching for a place to cross my party. To-night I took a swim, but found the waters disagreeably cold.

The chain of broken hills still continued on the north side, and, when near our camp of this date, circled in an amphitheatre, with its arch to the north. The basaltic columns, rising into the shape of spires, domes, and towers, gave it the appearance, as we approached, of a vast city on the hills. The distance of the crown of this amphitheatre, determined by angulation, is —— miles, and Francisco informs me that against its north base the Colorado strikes. So at this point, which is about six miles below our camp of this date, the Gila and Colorado must be near together. The hills and mountains appeared entirely destitute of vegetation, and on the plains could be seen, only at long intervals, a few stunted tufts of larrea Mexicana and wild wormwood, artemisia cana.

November 19.—The table-lands were the same as those described yesterday, but the valley widens gradually, and for most of the way is six or eight miles wide, and the soil excellent. Some remains of former settlements in broken pottery, corn-grinders, &c., but much fewer in number than above. Nine miles from camp a spur of mountains of an altered silicious sandstone came in from the southeast, sharp as the edge of a case-knife, and shooting into pinnacles. At their base we passed for half a mile over the sharp edges of a red, altered sandstone, dipping southwest about 80°, indeed nearly vertical.

On this spur was killed a mountain sheep, one of a large flock, from which we named it Goat's spur. We encamped on an island where the valley is contracted by sand buttes into what had been very recently the bed of the river. It was overgrown with willow, cane, Gila grass, flag-grass, &c. The pools in the old bed of the river were full of ducks, and all night the swan, brant, and geese, were passing; but they were as shy as if they had received their tuition on the Chesapeake bay, where they are continually chased by sportsmen. The whole island was tremulous with the motion of the mules grazing, and my observations were, therefore, not very satisfactory.

Eleven circum-meridian altitudes of Procyon, and twelve altitudes of Polaris, give the latitude of the camp 32° 43′ 38″.

November 20.—The table-lands were of sand, and the bottom of the river constantly received deposites from them, which changed its bed frequently, as might be seen from the different growths of cotton-wood marking the old land. Our road, about five miles from last night's camp, was traversed by a spur of coarse-grained granite, underlaid by old red sandstone, dipping some eighty degrees to the south and west. The direction of the spur was nearly parallel to those before noted, northwest and southeast, which is the direction of the axis of the maximum elevation of most of the mountains traversing the course of the Gila.

Our camp was pitched on a little patch of grass two miles from the river; night came on before the horses reached it, and they were without water for twenty-four hours; there was a pond near the camp, but so salt that the horses could not drink it.

At noon the thermometer was 74°, at 6 p. m. 52°, and at 6 o'clock the next morning 19°, which has been about the average range of temperature for the last two weeks.

November 21.—To-day we marched only eight and a half miles, and halted for a patch of

grama, which was an agreeable and beneficial change to our mules, which had been living on cane and willow for some days past.

The plains are now almost entirely of sand, and composed of sandy and calcareous loam with iron pyrites and common salt, covered sparsely with chamiza, larrea Mexicana, and a shrubby species of sage, (Salvia.)

I observed at night for latitude and time, and there being two occultations of Jupiter's satellites, I was tempted to observe them with our inferior telescope, which only gave us another proof of its uselessness for the purpose.

November 22.—Mr. Warner and I started before the advance sounded, and climbed the sharp spur of a continuous comb of mountains coming from the southeast, to try if we could see the Colorado of the west. The mountains rose abruptly from the plains, as they mostly do in this region, resembling in appearance large dykes terminating at top in a sharp ridge which a man could, at any part, straddle. They were of hard granite, pepper-and-salt colored, traversed by seams of white quartz. This spur gives the river Gila quite a bend to the north, and from that point to its mouth, which we reached at night, the river is straight in its general direction; but its course is crooked and dotted with sand-bars, by incursions from the sand-hills which now flank both its sides. The sand is brought down by the winds from the valley of the Colorado. Its volume seemed, I think, a little diminished, probably absorbed by the sand.

The day was warm, the dust oppressive, and the march, twenty-two miles, very long for our jaded and ill-fed brutes. The general's horse gave out, and he was obliged to mount his mule.

Most of the men were on foot, and a small party, composed chiefly of the general and staff, were a long way ahead of the straggling column, when, as we approached the end of our day's journey, every man was straightened in his saddle by our suddenly falling on a camp which, from the trail, we estimated at 1,000 men, who must have left that morning. Speculation was rife, but we all soon settled down to the opinion that it was General Castro and his troops; that he had succeeded in recruiting an army in Sonora, and was now on his return to California. Carson expressed the belief that he must be only ten miles below, at the crossing. Our force consisted only of one hundred and ten men. The general decided we were too few to be attacked, and must be the aggressive party; and if Castro's camp could be found, that he would attack it the moment night set in, and beat them before it was light enough to discover our force.

The position of our camp was decided, as usual, with reference to the grass. The lives of our animals were nearly as important as our own. It was pitched to-day in a little hollow encircled by a chain of sand-hills, overgrown with mezquite.

The sergeant of the general's guard was behind, his mule having broken down; and when he came in, reported having seen two Indians about five miles back. For a short time we supposed this immense trail was a band of Indians returning from a successful marauding expedition in Sonora or California; but this conjecture was soon dispelled by the appearance of a mounted Mexican on a sand butte overlooking our camp, who, after taking a deliberate survey, disappeared. The camp was arranged immediately for defence, and a cordon of sentinels stationed on the sand-hills.

The two howitzers did not arrive till nine o'clock, and the officer in charge, Lieutenant Hammond, reported that he had seen large fires to the right, apparently five miles distant, on the opposite side of the Gila.

The general said it was necessary for him to know who occupied the camp, its force, character, and destination. He ordered me to take my party and fifteen dragoons, for the purpose of reconnoitring. After beating about in the mezquite for some time, we struck a slough of the Gila, where grew some tall willows. Up one of these I sent a dragoon, who saw no fire, but whose ears were gladdened by the neighing of horses. He slipped down the tree much faster than he climbed it, quite enchanted with the hope of exchanging his weary mule for a charger. Instead of reporting what he had seen, he exclaimed, "Yes, sir, there are enough for us all." "Did you see the fires?" "No! but they are all on horses; I heard them neighing, and

they cover much ground." He pointed in the direction, and after proceeding a short distance we all heard distinctly the noise of the horses, indicating a large number.

Silence was enjoined, and we proceeded stealthily along for some time, when a bright fire blazed before us. I halted the guard, and with two dragoons, Londeau and Martinez, proceeded unobserved until within a few feet of the fire. Before it stood an armed Mexican. I sent Londeau and Martinez with orders to assume the occupation of trappers, and ascertain who, and what, the man guarded. The conference was short; other Mexicans advanced, and I sent in man for man. It was not Castro, as we expected, but a party of Mexicans with five hundred horses from California, on their way to Sonora for the benefit of Castro.

I took the four principal men to the general, and left a guard to watch the camp and see that no attempt was made to escape. The men were examined separately, and each gave a different account of the ownership and destination of the horses.

The chief of the party, a tall, venerable-looking man, represented himself to be a poor employé of several rich men engaged in supplying the Sonora market with horses. We subsequently learned that he was no less a personage than José Maria Leguna, a colonel in the Mexican service.

November 23.—We did not move camp to-day, in order to make a refit from last night's capture, and give our mules an opportunity to pick what little grass they could before taking the desert of ninety miles, which lies on the other side of the Colorado, and between us and water.

Warner, Stanly, and myself saddled up to visit the junction of the Gila and Colorado, which we found due north from our camp, and about a mile and a half distant. The day was stormy, the wind blowing fiercely from the north. We mounted a butte of feldspathic granite, and, looking 25° east of north, the course of the Colorado was tracked by clouds of flying sand. The Gila comes into it nearly at right-angles, and the point of junction, strangely chosen, is the hard butte through which, with their united forces, they cut a cañon and then flow off due magnetic west, in a direction the resultant due to the relative strength of the rivers.

The walls of the cañon are vertical, and about fifty feet high and one thousand feet long. Almost before entering the cañon, in descending the Gila, its sea-green waters are lost in the chrome-colored hue of the Colorado. For a distance of three or four miles below the junction the river is perfectly straight, and about six hundred feet wide; and up at least to this point, there is little doubt that the Colorado is always navigable for steamboats. Above, the Colorado is full of shifting sand-bars, but is, no doubt, to a great extent susceptible of navigation.

The Gila, at certain stages, might be navigated up to the Pimos village, and possibly with small flat-boats at all stages of water.

Near the junction, on the north side, are the remains of an old Spanish church, built near the beginning of the seventeenth century, by the renowned missionary, Father Kino. The mission was eventually sacked by the Indians, and the inhabitants all murdered or driven off. It will probably yet be the seat of a city of wealth and importance, most of the mineral and fur regions of a vast extent of country being drained by the two rivers. The stone butte, through which they have cut their passage, is not more than a mile in length. The Gila once flowed to the south, and the Colorado to the north of this butte, and the point of junction was below. What freak of nature united their efforts in forcing the butte is difficult to say. During freshets, it is probable the rivers now discharge their surplus waters through these old channels. Francisco informs me that the Colorado, seven days' travel up from the butte, continues pretty much as we saw it.

There a cañon is reached, impassable for horses or canoes. The country between is settled by the Coyotaros, or wolf-eaters, *cochinears*, (dirty fellows;) Los Tontears, or fools; and the Garroteros, or club Indians. These cultivate melons, beans, and maize.

On our return we met a Mexican, well mounted and muffled in his blanket. I asked him

where he was going; he said to hunt horses. As he passed, I observed in each of his holsters the neck of a bottle, and on his croup a fresh-made sack, with other evidences of a preparation for a journey. Much against his taste, I invited him to follow me to camp; several times he begged me to let him go for a moment—that he would soon return. His anxiety to be released increased my determination not to comply with his request. I took him to General Kearney, and explained to him the suspicious circumstances under which I had taken him, and that his capture would prove of some importance. He was immediately searched, and in his wallet was found the mail from California, which was of course opened.

Among the letters was one addressed to General José Castro, at Alta, one to Antonio Castro, and others to men of note in Sonora. All suspected of relating to public affairs were read, and we ascertained from them that a counter revolution had taken place in California; that the Americans were expelled from Santa Barbara, Puebla de los Angeles, and other places; and that Robideaux, the brother of our interpreter, who had been appointed alcalde by the Americans, was a prisoner in jail. They all spoke exultingly of having thrown off "the detestable Anglo-Yankee yoke," and congratulated themselves that the tri-color once more floated in California.

Captain Flores was named as the general and governor *pro tem.*, and the enthusiasm of the people described as overflowing in the cause of emancipation from the Yankee yoke. One letter gave a minute and detailed account of a victory stated to have been obtained over the Americans. It stated that 450 men landed at San Pedro, and were met, defeated, and driven back to the fort at San Pedro. This last was attributed by us to Mexican braggadocio, as it is usual with them to represent their defeats as victories; but that there was a disturbance of a serious kind in the province we could not doubt, from the uniformity of the accounts on that head. We also learned that the horses captured were in part for General Castro. Nothing more was wanting to legitimize our capture, and Captain Moore was directed to remount his men.

The letters contained precise information, but being dated so far back as the 15th October, left us in great doubt as to the real state of affairs in California; and the Mexicans played their parts so dexterously, it was not in our power to exact the truth from them. One of the party, who had received some little favor from Carson in California, was well plied with brandy, but all that could be extorted from him was the advice that we should not think of going to the Puebla with our small force—counsel that our friend soon learned we had not the slightest intention of following.

The position of our camp, about one mile and a half south of the junction of the Colorado and Gila rivers, determined by 12 circum-meridian altitudes of Sirius, 6 of Saturn, and 12 altitudes of Polaris, is latitude 32° 42′ 09″.

The clouds, together with my military duties, interfered with taking a more elaborate set of lunar distances. An inspection of the individual observations for latitude will show that the latitude of the camp may be relied on, but I regret it was not in my power to measure the exact distance of my camp from the mouth of the Gila.

At night, passing my arm over the surface of the fur robe in which I was enveloped, electric sparks were discharged in such quantities as to make a very luminous appearance, and a noise like the rattle of a snake.

November 24.—We visited the camp of our Mexican friends, whom the general determined to release, and found there was a woman with the party in the agonies of childbirth. She was at once furnished from our stores with all the comforts we possessed. This poor creature had been dragged along, in her delicate situation, over a fearful desert.

The captured horses were all wild, and but little adapted for immediate service, but there was rare sport in catching them, and we saw, for the first time, the lazo thrown with inimitable skill. It is a saying in Chihuahua that "a Californian can throw the lazo as well with his foot as a Mexican can with his hand," and the scene before us gave us an idea of its truth. There was a wild stallion, of great beauty, which defied the fleetest horse and the most expert rider.

At length a boy of fourteen, a Californian, whose graceful riding was the constant subject of admiration, piqued by repeated failures, mounted a fresh horse, and, followed by an Indian, launched fiercely at the stallion. His lariat darted from his hand with the force and precision of a rifle-ball, and rested on the neck of the fugitive. The Indian at the same moment made a successful throw; but the stallion was too stout for both, and dashed off at full speed, with both ropes flying in the air like wings. The perfect representation of Pegasus, he took a sweep, and, followed by his pursuers, came thundering down the dry bed of the river. The lazos were now trailing on the ground, and the gallant young Spaniard, taking advantage of the circumstance, stooped from his flying horse and caught one in his hand. It was the work of a moment to make it fast to the pommel of his saddle, and by a short turn of his own horse he threw the stallion a complete somerset, and the game was secure.

We travelled over a sandy plain a few miles, and descended into the wide bed of the Colorado, overgrown thickly with mezquite, willow, and cotton-wood. After making about ten miles, we encamped abreast of the ford, on a plateau covered with young willows, of which our horses were to lay in a sufficient supply to last them over the desert. Since writing the above we have found a good patch of grass, and our people have been ordered to cut a ration for each mule to carry along.

The night was excessively cold and damp, and in the morning our blankets were covered with a little dew. For the first time the bugle calls were distinctly reverberated, showing the atmospheric change as we approach the coast and descend into the neighborhood of the sea-level. In New Mexico, even when surrounded by hills and perpendicular walls, the report of fire-arms and the sound of the bugle were unattended with any distinct echo. The reports were sharp and unpleasant—not rounded, as here, by the reverberation.

The country from the Arkansas to this point, more than twelve hundred miles, in its adaptation to agriculture, has peculiarities which must forever stamp themselves upon the population who inhabit it. All of North Mexico, embracing New Mexico, Chihuahua, Sonora, and the Californias, as far north as the Sacramento, is, as far as the best information goes, the same in the physical character of its surface, and differs but little in climate or products.

In no part of this vast tract can the rains from Heaven be relied upon, to any extent, for the cultivation of the soil. The earth is destitute of trees, and in great part also of any vegetation whatever.

A few feeble streams flow in different directions from the great mountains which in many places traverse this region. These streams are separated, sometimes by plains, and sometimes by mountains, without water and without vegetation, and which may be called deserts, so far as they perform any useful part in the sustenance of animal life. The cultivation of the earth is therefore confined to those narrow strips of land which are within the level of the waters of the streams, and wherever practised in a community with any success, or to any extent, involves a degree of subordination and absolute obedience to a chief repugnant to the habits of our people.

The chief, who directs the time and the quantity of the precious irrigating water, must be implicitly obeyed by the whole community. A departure from his orders, by the waste of water or unjust distribution of it, or neglect to make the proper embankments, may endanger the means of subsistence of many people. He must, therefore, be armed with power to punish promptly and immediately.

The profits of labor are too inadequate for the existence of negro slavery. Slavery, as practised by the Mexicans—under the form of peonage, which enables the master to get the services of the adult while in the prime of life, without the obligation of rearing him in infancy, supporting him in old age, or maintaining his family—affords no data for estimating the profits of slave labor as it exists in the United States.

No one who has ever visited this country, and who is acquainted with the character and value of slave labor in the United States, would ever think of bringing his own slaves here with any

view to profit; much less would he purchase slaves for such a purpose. Their labor here, if they could be retained as slaves, among peons nearly of their own color, would never repay the cost of transportation, much less the additional purchase money.

I made many inquiries as to the character of the vast region of country embraced in the triangle formed by the Colorado of the west, the Del Norte, and the Gila; and the information collected will, at some future time, be thrown into notes for the benefit of future explorers, but are not given in this work, as I profess to write only of what I saw.

From all that I learn, the country does not differ materially in its physical character from New Mexico, except, perhaps, being less denuded of soil and vegetation. The sources of the Salinas, the San Francisco, Azul, San Carlos, and Prieto, tributaries of the Gila, take their rise in it. About their headwaters, and occasionally along their courses, are presented sections of land capable of irrigation.

The whole extent, except on the margin of streams, is said to be destitute of forest trees. The Apaches, a very numerous race, and the Navajoes, are the chief occupants; but there are many minor bands, who, unlike the Apaches and Navajoes, are not nomadic, but have fixed habitations. Among the most remarkable of these are the Soones, most of whom are said to be Albinos. The latter cultivate the soil, and live in peace with their more numerous and savage neighbors.

Departing from the ford of the Colorado in the direction of Sonora, there is a fearful desert to encounter. Altar, a small town, with a Mexican garrison, is the nearest settlement.

All accounts concur in representing the journey as one of extreme hardship, and even peril. The distance is not exactly known, but it is variously represented to be from four to seven days' journey. Persons bound for Sonora from California, who do not mind a circuitous route, should ascend the Gila as far as the Pimos village, and thence penetrate the province by way of Tucson.

November 25.—At the ford the Colorado is 1,500 feet wide, and flows at the rate of a mile and a half per hour. Its greatest depth in the channel, at the ford where we crossed, is four feet. The banks are low, not more than four feet high, and, judging from indications, sometimes, though not frequently, overflowed. Its general appearance at this point is much like that of the Arkansas, with its turbid waters and many shifting sand islands.

The ford is entered at the lower extremity of the plateau upon which we encamped, and leads down the river, crossing three sand islands, which we sketched; but as they are constantly shifting, the sketch will perhaps afford no guide to the traveller, and may even lead him into error. It is therefore not furnished. The ford is narrow and circuitous, and a few feet to the right or left sets a horse afloat. This happened to my own horse.

INDEX.

	Page.
Apache Indians, depredations of	11
country occupied by	20
Atmosphere, peculiarity of	6
changes of, and effect upon sound	19
Contents	5
Corn mills, ruins of	7, 15
Colorado river, junction with the Gila	17, 20
navigability	17
Coyotaros (*wolf eaters*) Indians	17
Cochinears (*dirty fellows*) Indians	17
Country, general description of between the Arkansas and Colorado rivers	19
Colorado Desert	20
Davidson, Lieut.	8
Game	6, 14, 15
"Guia," (*guide to gold*)	5
Gila river, junction with the San Pedro	5
course through a crater	7
camp on	13
junction with the Colorado	17
navigability	17
Garroteros (*club*) Indians	17
Humphreys, Capt. A. A., letter to Secretary of War	3
Hieroglyphics	14, 15
Inscriptions	14, 15
Indians, visits from	6
Piñon Lanos	6
Maricopas	8, 11
Pimos	8, 9, 10, 11
Coyotaros	17
Cochinears	17
Garroteros	17
Los Tontears	17
Apaches	20
Navajoes	20
Soones	20
Indian settlements, remains of	7, 8, 15
spinning jenny	9
tradition	10
Incantation formula	7
Kearney, General	13, 18
Llunas Antonio (chief of the Pimos)	9, 10
Los Tontears (*fools*) Indians	17
Letter, Capt. Humphreys' to Secretary of War	3
intercepted Mexican letters from California	18
Lassoing horses, expertness of the Californians, exciting sport	19
Maricopas Indians	11
women	12
Messio José, (governor of the Maricopas)	11
Mirage	13

	Page.
Mexican camp	16
Mexican, capture of, with California mail	18
Mineral Creek	6
Navajoe Indians	20
Potteries, ruins of	6, 7, 8, 9, 15
Pinole	10
Pimos Indians, traffic with	8, 9, 10
manner of cultivating land, dress	9
character, huts	10
possessions, religion, disposition	11
Peonage of the Mexicans	19
Ruins of potteries	6, 7, 8, 9, 15
corn mills	7, 15
Indian settlements	7, 8, 15
zequias	8, 13
casa montezuma	9
Spanish church	17
Rio San Francisco	11
San Pedro river, junction with the Gila	5
Storm	5
Spinning jenny	10
Shell	8, 13
Swords, Major	10
Soones Indians	20
Salt river	11
Zequias, remains of	8, 13